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MANAGEMENT ENGINEERING

THE JOURNAL OF PRODUCTION

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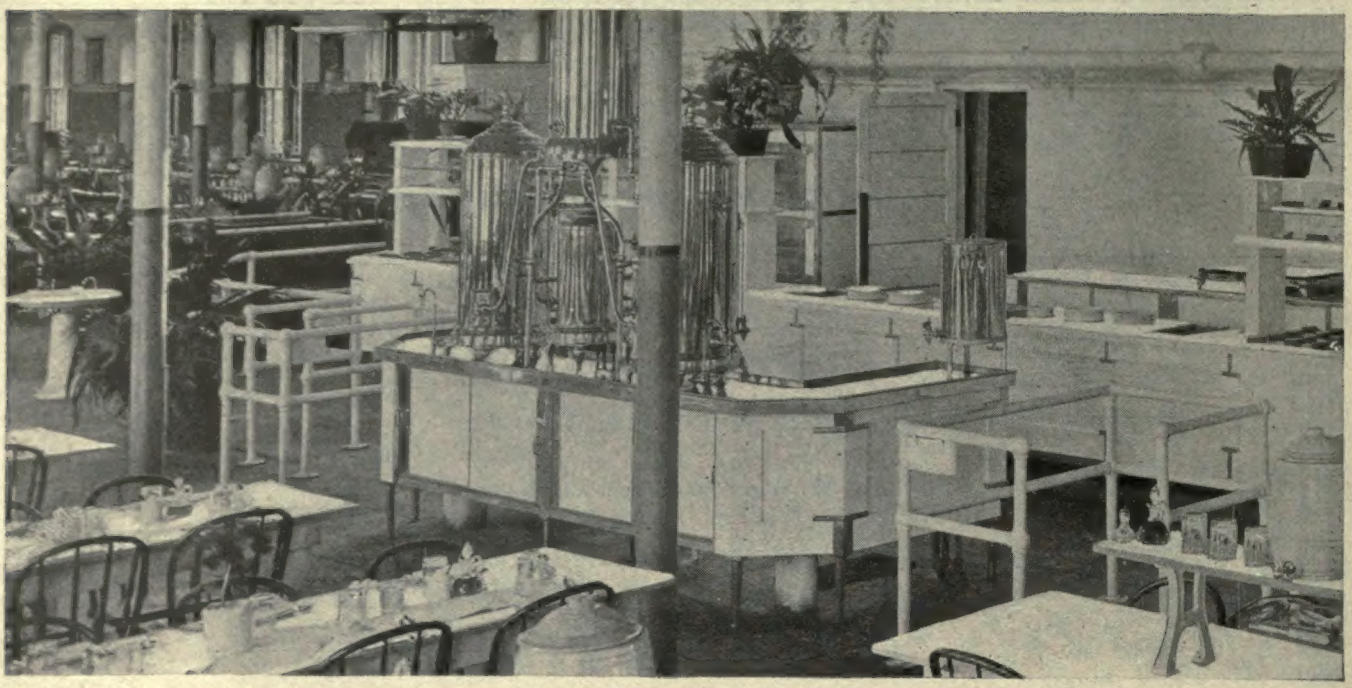

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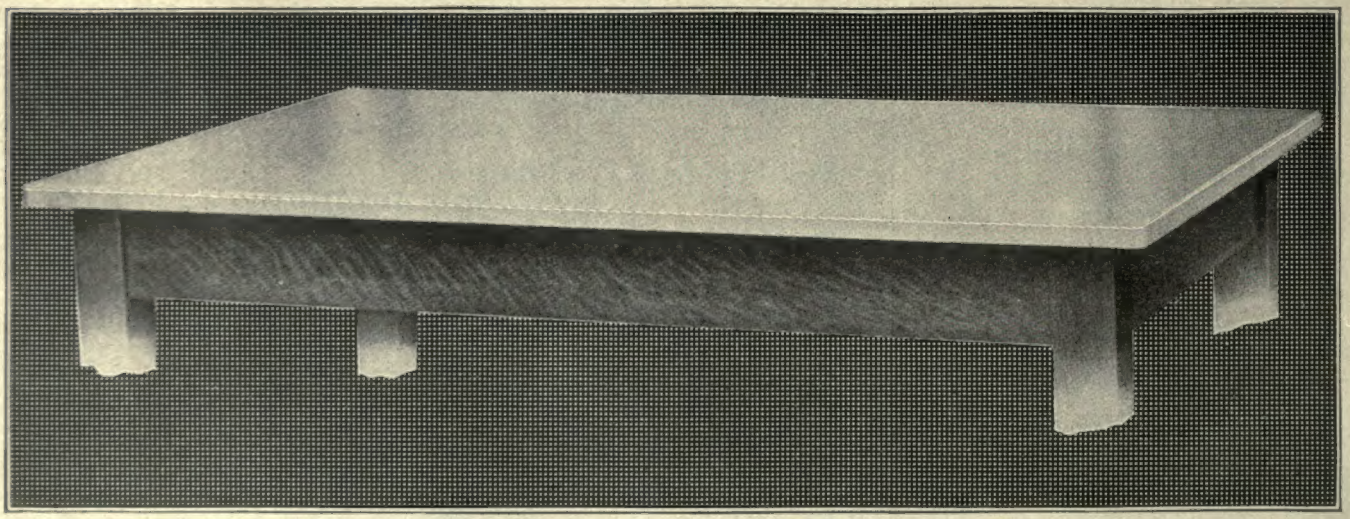

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MANAGEMENT ENGINEERING

THE JOURNAL OF PRODUCTION

VOLUME I JULY, 1921 NUMBER I

Engineering societies 62 (06)

The Pioneer Spirit in Engineering

As Developed in The Federated American Engineering Societies

By E. S. CARMAN

President, The American Society of Mechanical Engineers

THROUGH the formation of The Federated American Engineering Societies, the youngest of the professions has voluntarily accepted its full responsibility of service to the community, for the desire to serve now actuating American engineering has at last found expression in united action. The first outcome is the greatest engineering society in the world. While this is, as yet, but little more than a potential step, for the organization has been at work only a few months, already the widespread value of engineering thought and achievement is beginning to be appreciated by the public to an extent unthought of even a short year ago.

It stands to the credit of the 110,000 engineers, whose delegates met at the organizing conference in Washington in June of last year, that not one of their representatives cast a vote opposing the resolution that the societies should constitute "a comprehensive organization dedicated to the service of the community, state and nation," when this principle of service was moved and supported by the attending delegates as the purpose of the proposed organization.

THE ENGINEERS' PROBLEM OF THE FUTURE

It is a commonplace observation that this century is to see many changes and readjustments, particularly in regard to the industrial structure upon which civilization rests. Engineers are destined by the very nature of their calling to be a controlling factor in the new economic and industrial conditions that must prevail. Hence it may safely be forecast that the right solution of many of our present problems will come all the sooner because of the united front now presented by men who "know what to do, and how to do it." With this prophecy in mind, it is worth while to review briefly the influences that have led to the development of an agency through which the engineering profession can speak frequently and authoritatively tendering, when necessary, its technical knowledge and mature judgment on matters of collective concern.

Less than five years ago the profession was scattered. The 120 or more societies into which it was divided had found no way to co-operate or secure common action for there were no generally accepted ideals, and objects. Those best known to the public were the four national engineering societies with their many local sections spread throughout the country. In addition, there were many state engineering societies and in a few localities what might be termed "regional" organizations. Some of these local and regional associations were complete societies within themselves, while others were a group of the local sections of national societies and, in a few cases, a combination of such local sections into state-wide organizations. The attempt to unify engineers met with varying degrees of success, but without even a minor part of the profession becoming sufficiently influential to make its voice heard in public affairs.

It was natural for the idea of co-operation and united action to spring from the headquarters of the national engineering societies. So we find that prior to the war, several efforts were made to secure united action on the part of the national societies through the instrumentality of joint committees. As a rule, each of these attempts was restricted to some phase of engineering activity of common interest to all branches of the profession. It must be confessed with all fairness that these efforts met with scant success. It remained for the war to give the impulse necessary to create a united and co-ordinated organization.

TWO MAJOR INFLUENCES IN ENGINEERING

Succeeding events have proved that this impulse was one of the major influences in developing The Federated American Engineering Societies, and another movement which must be properly evaluated

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had its rise in the Middle West. These two movements must be considered together, although quite naturally the one growing out of the activities of the national societies should be considered first, as in point of time it was the earlier effort.

Early in the spring of 1917, Engineering Council was formed as a department of the United Engineering Society, and the by-laws of that organization adopted at that time defined its purpose as: "To provide for a co-operation between the founder societies for the proper consideration of questions of joint interest to engineers and to the public, and to provide a means for united action upon questions of common concern to engineers."

Under the plan of organization, Engineering Council was given power to speak authoritatively for its member societies upon public questions of interest to engineers unless objection was made by a majority of the representatives present of one of the founder societies, or by one-fourth of the representatives present. At the outset, Engineering Council united approximately 30,000 engineers, and at that time was the largest organization of its kind in existence. A wise provision in its plan permitted the election to membership of other engineering organizations. Thus, the American Society for Testing Materials became a member in February, 1919, and the American Engineering Railway Association joined in April, 1920.

Despite the fact that Engineering Council accomplished much of value to engineers and the profession, it was felt by many that its organization was undemocratic and incapable of uniting the profession as a whole. A fatal weakness was the absence of any method by which state or local engineering societies could become members. Nevertheless, during the years immediately following 1917, these local and regional associations grew and were becoming influential in their respective localities.

RISE AND WORK OF "DEVELOPMENT COMMITTEES"

During 1919, each of the Four Founder Societies appointed a committee to state the aims of its organization. These committees became generally known as "Development Committees." Before their deliberations were completed, the possibility of good that might come from joint studies became apparent, and so a Joint Conference Committee was formed to consider and prepare a report which should lay the foundations for a national organization. On January 23, 1920, a conference was held at which were present the members of the Joint Conference Committee, the councils of the Four Founder Societies, and representatives of Engineering Council and of the United Engineering Society. Resolutions were passed instructing the Joint Conference Committee to call a conference of the representatives of the engineering organizations throughout the United States to formulate plans for a federation of engineering societies. The first of the specific objects which this organization was expected to perform was phrased in this way: "To render a maximum of service to the nation through unity of action."

Acting under the authority given by these resolutions the Joint Conference Committee called together delegates of the engineering societies of the United States in Washington, D. C., on June 3 and 4, 1920. At this meeting The Federated American Engineering Societies was formed, and plans laid for the first meeting of its executive body known as American Engineering Council. In all 71 societies sent 135 delegates representing upwards of 110,000 engineers. The meeting was filled with dramatic interest, for the object sought placed it above all other engineer gatherings ever held.

A striking feature was the enthusiasm and support of delegates representing the local and regional societies. From the moment this spirit was shown the success of the great movement was assured.

At this point we must retrace our steps to indicate and evaluate another influence that had its rise in the Middle West, and that undoubtedly accounted for much of the local support.

THE MID-WEST INFLUENCE

Previous to the time of the creation of the Joint Conference Committee of the Four Founder Societies, engineers of the Middle West had expressed a desire to form an engineering organization, national in its scope. Numerous conferences had been held, and an effort made in May, 1918, to crystallize these ideas. This constructive step occurred at the time of the Fourth Annual Convention of the American Association of Engineers. Members of this organization met jointly with the Committee on Engineering Co-operation, and delegates from national, state, and local engineering societies.

At this gathering several plans were discussed for the formation of an engineering organization to represent the engineer in national affairs. The first was presented by Gardner S. Williams, who favored strong state or local societies dealing absolutely with state matters and having delegate representation in a central organization to deal with national matters. C. E. Drayer, then of The Cleveland Engineering Society, presented a plan proposed by the Committee on Engineering Co-operation. This advocated an inter-relationship of existing societies without the creation of any new body or association. Hunter McDonald suggested state organizations with a central government of delegates empowered to co-operate with the existing Engineering Council. Under this plan separate organizations in any locality would have been combined and the national societies retain their organization and autonomy for technical purposes but surrender all other activities to the central body.

As a further manifestation of this desire to organize for participation in public affairs, a Joint War Committee of 19 engineering and technical societies was created in Chicago on January 4, 1918, through the efforts of the Western Society of Engineers. The purpose of its formation was: "To enable the technical societies of the Chicago zone to call into play the efforts

of the members of the various societies as occasion might arise and to co-ordinate their activities in a most effective manner to help win the war."

THE UNION OF WILL AND PURPOSE

Although The Federated American Engineering Societies came into being through a conference called by the Joint Conference Committee of the Four Founder Societies, still the enthusiasm of local and regional organizations was quite as important a factor in making the organizing conference a success as that coming from the national society. This is a most happy situation in retrospect, for it indicates a complete union of will and purpose on the part of engineers throughout the length and breadth of the United States without reference to particular society affiliation.

The only break in the feeling of unity that prevailed at the first meeting of American Engineering Council, the governing body of The Federated American Engineering Societies, was that due to the absence of representatives from the American Society of Civil Engineers. It was the expressed feeling of Council members that the American Society of Civil Engineers will yet become a member of The Federated American Engineering Societies.

To continue the story of this development a little further, the first meeting of American Engineering Council took place in Washington, D. C., on November 18 and 19, 1920, and was immediately followed by the first meeting of the Executive Board of the Council. Events came rapidly thereafter as Engineering Council prepared to suspend and turn over its activities to the new organization. When this change became effective on January 3, 1921, it transferred to the American Engineering Council a considerable staff and much uncompleted work of the Council, while the new organization at the same time took over the employment service which had been conducted by the Four Founder Societies. To use a familiar phrase, on that date the new society became a "going concern."

ELIMINATION OF WASTE IN INDUSTRY

In the early paragraphs of this brief survey of events, the forecast was ventured that the engineers of this country through their new organization would exert a profound influence upon our industrial readjustment. The first work undertaken by The American Engineering Council is indicative of what we may expect from its activities.

At the suggestion of Herbert Hoover, the first President of the Council—who has recently resigned—the Committee on Elimination of Waste in Industry was established early in January, charged with the responsibility of studying those factors that restrict production, a matter of vital interest to everyone: owners, management, workers and society at large.

The rapidity with which this committee has done its work is little short of astonishing, for its report was submitted to the Council on June 3.

The findings of this committee, based on engineering investigations, lay the foundation for an appreciation by the public of the magnitude of some of the economic and engineering factors upon which depend the stability and prosperity of industry. A number of popular beliefs regarding the nature of the problem seem to have scant foundation; in fact, none at all. The waste due to labor disturbance appears to be of far less importance than many other losses, while the public cannot be held responsible for wastes over which it has no control and to which it does not contribute.

On the other hand, as engineers expected, wastes due to mis-management and mal-functioning of industry have been emphasized more forcibly than ever before. This places an increased burden of responsibility upon the engineering profession, for the second part of the first sentence of the preamble to the Constitution of The Federated American Engineering Societies adds to the accepted definition of engineering the management concept, "and the art of organizing and of directing human activities in connection therewith."

One more feature in this report promises much. Its opening paragraphs give a flash of idealism, a continuing of the spirit which brought the national organization into being, phrased in this wise:

"This report is the first work undertaken by The Federated American Engineering Societies in rendering public service. It discloses losses and wastes due to the restraint and dissipation of the creative power of those who work in industry. It lays the foundation for knowledge of the destructive influences which have too much controlled in the past. From this knowledge will grow the certain vision that mental and moral forces must be added to the physical resources now employed if industry is to serve all who are dependent upon its continuous and effective operation."

As the years pass, those who have had the privilege of participating in the founding of The Federated American Engineering Societies will look back upon those times and associations as among their brightest memories. Truly, the future of the youngest of the professions is an attractive one, if the great impelling motive declared at the beginning of its united organization continues to govern throughout the years.

Management engineering *658*

What is Management Engineering

By PAUL KREUZPOINTNER

THE intensive technical control of all human activities and necessities of life has come about by means of scientific and mechanical agencies, and those who have mastered the knowledge and application of these agencies have grown into a large class called engineers. Furthermore the increasingly intensive application and use of natural resources has reacted in a stimulating fashion upon the human mind and released energy for new discoveries and in-

ventions, thus increasing the importance of the engineer as a contributing and regulating agent. Hence it is not only natural, but economically and ethically desirable, for the engineer of today to become self-conscious of his power and influence as a regulative instrumentality both individually and collectively.

According to the law of evolution the specialization of engineering activities into various branches resulted in the concentration of professional consciousness and power within the limits of these branches, and the consequent raising of their standard of usefulness to themselves and to the community. What wonder then that with the ever-widening field of the application of technical knowledge the engineering fraternity has felt the need of centralizing its power in The Federated American Engineering Societies? This movement is welcome as a manifestation of social progress, as long as the guiding principles of this power are ethical, social, and economic, rather than political and financial.

A Phase of National Development

This centralizing movement is simply a phase in the history of the development and expansion of the United States, having its origin in wealth of resources and free institutions. The present diversity in engineering occupations can be traced back, step by step, to the pioneer surveyor who in his day was the sole arbiter in all technical questions. Just as the millwright was the universal mechanic until the middle of the last century when the machinist took his place, so the ubiquitous Jack of all trades of the early days has been replaced by the other extreme, the semiskilled machine specialist.

When Governor Winthrop of Massachusetts wrote to his son in 1644 that their blast furnace near Salem was doing exceedingly well, producing eight tons of pig iron weekly, there was neither need nor room for a metallurgical engineer. In contrast, a modern blast furnace with 600 tons production in 24 hours calls for the highest specialized engineering talent of the day.

The Crux of the Question

The evolution of the United States from a primitive colonial community to the present mighty republic with its world-wide political influence was necessarily accompanied by a corresponding development of its natural resources. These in turn fostered a rapid increase of population, resulting in the present commanding industrial and commercial position. Nor is the concept of this industrial status of the United States so very modern. Alexander Hamilton, the first treasurer of the United States, with wonderful foresight in his communication to Congress on Manufactures, December 5, 1791, pointed to the possible increasing use of machinery as a result of the development of our resources with a consequent division of labor into technical, agricultural, and commercial occupations. The present extent of American industry has verified this early vision of Hamilton.

But this change has also produced a shifting in habits, customs, and modes of living. The necessity of co-operation between individuals, communities, and the states has modified the excessive individualism of the pioneer days. In fact, this country is now passing through a transitory period from pioneer individualism to collectivism in conformity with the needs of an ever increasing density of population and of economic pressure.

In the change from the individual and the independent action of the earlier engineer to the present co-operative actions, and the unity of engineering societies with their consequent concentration of power, and in the more recent movement toward centralized action through the national federation of engineering societies, we find the reason and explanation of the term "management engineering."

The technical engineer acts individually within a circumscribed sphere of limited interests confined to the application of specialized engineering principles. While so engaged the relation of the individual engineer to the professional, financial, and technical advancement of his profession is of secondary importance and he can accomplish but little toward that desirable advancement, however willing he may be.

Engineers Influence All Human Activities

Management engineering, however, as represented by the activities, good-will, and unity of the federated engineering societies, comprises the whole realm of engineering talent, experience, training, and knowledge. As such, it is representative of and responsible for progress in methods of training and in the acquirement of professional engineering ability, and that conduct necessary to gain public confidence for the engineer, individually and as a group. This, in turn, requires the united action of the engineers, as citizens as well as in the capacity of technically trained men, in the management and regulation of public affairs. Since public as well as private life is almost entirely regulated by mechanical devices and technical knowledge, the engineer's influence penetrates and permeates all human activities.

Hence, since engineering, and the technical, ethical and civic standing of the engineers has become part and parcel of the mental and physical welfare of the community and of the nation, and since management engineering comprises the whole of the professional, its centralized power applied therefore not only to the management of individual interests, but likewise to the life of all the people of the community and of the nation.

So while the technical engineer necessarily pursues an individualistic line of activity in conformity with his professional requirements, the combined body of engineers unitedly participate as trained experts and citizens in the daily affairs of public life. Moreover, as managers and directors of engineering work and industrial effort, they are upholding the very foundations of our present-day civilization.

Training as a Factor in Reducing Labor Cost

How Instructing the Worker Enhances His Skill, Increases Production and Lowers Manufacturing Costs

By J. F. JOHNSON

President, Johnson & Timperly, Consultants in Industrial Relations

RESULTS obtained during the past two years in a new phase of industrial engineering show quite clearly that the ambition to get results too often blinds one's vision to the fundamentals that underlie the processes of production. Managers of plants have chiefly concerned themselves with materials and machinery, and have not given enough thought to the proper development of the men who were to handle them.

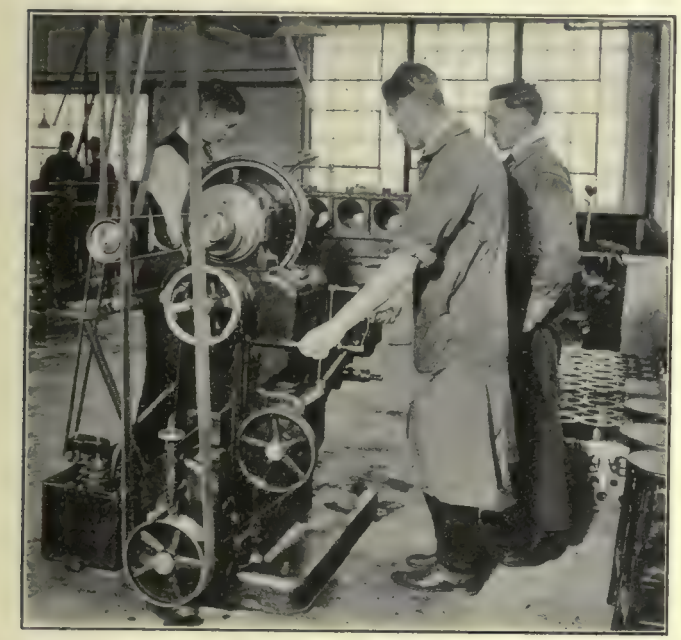


FIG. 1 INSTRUCTING AN OPERATOR IN THE USE OF A MILLING MACHINE

Of the three fundamental factors in production—materials, forces, and intelligence—intelligence is the one most limited in supply, and yet strangely enough it has been the one most neglected in the efforts that have been made to increase production. We have highly organized our methods of handling and processing materials and we have built complicated and wonderful machinery in an effort to use the forces of nature to advantage. But what have we done to develop and refine the third factor?

When men are needed for work it is common practice to employ those who "look good" and put them on the job. After that little or no attention is paid to them and the knowledge they acquire of the methods of handling materials and machinery they get as well as they can through their own efforts. But this self-instruction requires much time and entails considerable waste of materials; moreover, the information the man obtains is incomplete and he forms incorrect working habits. This of course has a corresponding effect upon individual production and proves a handicap in the worker's development as an operator.

In a large measure the failure to train men properly explains the very common deficiencies of high unit labor costs, low unit production, large labor turnover, wastage, and a large number of workers below the department's average of efficiency. Through our neglect of this fundamental factor we have been speeding along on an unbalanced program unaware, apparently, of the main causes of our failures.

If a job is to be successful it must be performed with intelligence in keeping with its requirements. We do not fail to furnish an adequate amount of material of the proper quality to carry on the job, nor do we fail to provide the proper amount of power or suitable machinery. We are contented, however, to take a chance on the man, accepting almost any applicant who tells us that he has the necessary qualifications and we hope that in due time he will "get the hang of things."

TRAINING SHOULD BE GIVEN AT OUTSET OF WORK

The job should be performed intelligently from the very outset, for it is only in this way that the results will be commensurate with those obtained through the efficient handling of the other two elements of production. Low unit labor cost and high unit production will then be obtained and wastage will be at a minimum. In addition, damages to equipment, department "deadwood," and unnecessary "friction" will be reduced.

In one factory which has made adequate provision for the development of skill in workingmen there has resulted a decrease in unit labor costs of 43 per cent and an increase in unit production of 98.5 per cent. Results of a similar character have been obtained in other cases, driving home quite forcefully the importance of providing for this essential factor of more skilled labor.

Large organizations, notably the National Chamber of Commerce, also the National Metal Trades Association, have made this matter of more efficient labor an association issue. Their endeavors have already brought vision to many of their members and as one of them has stated, "nothing but ignorance can ques-

tion the value of such a program." Manufacturers who were formerly obtaining what they regarded as excellent results with highly developed systems and equipment have increased their net result to a notable degree by a corresponding development of this third fundamental which they apparently had left out of their calculations.

Each manufacturer, however, can obtain for himself a very convincing picture of how this condition among

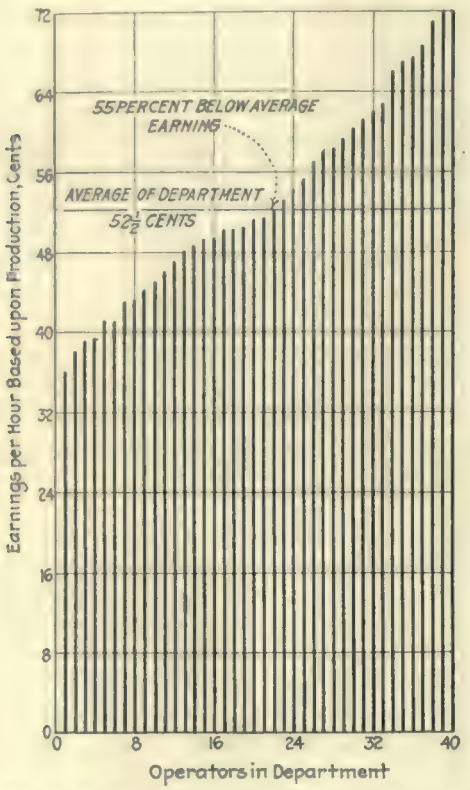


FIG. 2 EARNINGS PER HOUR OF INDIVIDUAL OPERATORS BASED ON PRODUCTION

his workers has affected the unit labor costs in his own factory. He need only take a cross section of the unit production of an average department. An example of how this has worked out in the case of an enterprising shop which is well organized in materials and forces, is illustrated by the chart shown in Fig. 2, which represents the individual earnings per hour as based on the production of the 40 operators of a department. Of these 40 workers, 22 were below the average of their department, and the cause of this condition was the failure to consider the third element in production—namely intelligence on the part of labor.

But merely to supply the men to do a piece of work is not furnishing all that is needed to meet production requirements, even though a certain percentage of the new workers may be highly efficient. And yet is this not the common every-day experience we have been having? As long, however, as intelligence on the part of the operators is necessary—and it can be determined definitely how much of it is necessary for any specific task—it would seem wise to provide in the regular division of management some means whereby this degree of intelligence can be developed to satisfy the requirements. A special department might be organized for the purpose which would bear the same relation to the production scheme that the heat-treating department bears to the machinery department. Tools needed in machining are first prepared in the heat-treating department before they are assigned to their tasks in the machinery department.

DEVELOPMENT COMES ONLY THROUGH EDUCATION

This development of the individual worker, however, can come only through education, and education which aims to fit a worker to his job is of a special type that might well be called job instruction. A few factories have realized this fundamental need and they have programs for providing all workers with an opportunity to acquire the training necessary for the proper performance of their particular tasks. Their policy in this respect is the underlying reason for their obtaining a high unit production with a low unit labor cost.

How the training of operators can be accomplished is perhaps best shown by reviewing the program now being carried out in a factory of about 800 employees, which is engaged in the making of garment accessories. The aim in this plant was to have a balanced production program and to provide for all the operations, the kind and amount of "instruction" needed, to produce the best results. At the outset, each process was carefully analyzed into its various details, and a study was made of the most proficient operators to discover just

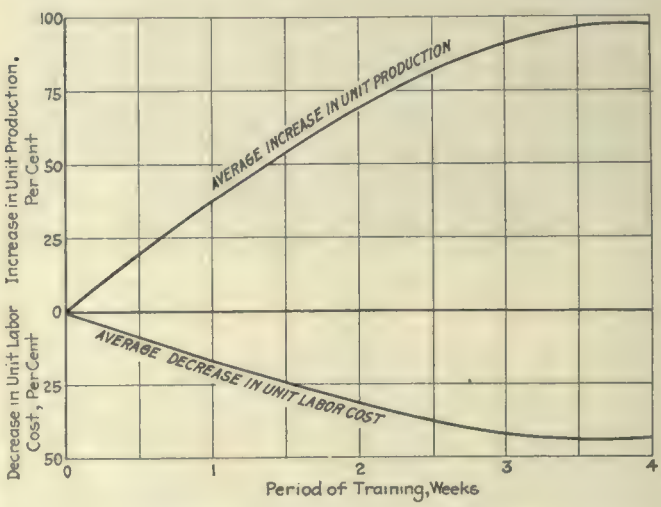


FIG. 3 THE EFFECT OF TRAINING ON UNIT PRODUCTION AND ON UNIT LABOR COSTS

why they were so superior. As a result of this study the best manner, both as to time and effort required to perform each detail of every job, was determined, and after having decided upon the "one best way," as it was called, its details were arranged in an order easily taught and the methods to be followed in teaching the workers these details were formulated.

The instructors were next selected from among the best qualified men in the department and given an intensive and thorough training in their new job. They

were trained for their task in keeping with the general program. They were taught how to teach others, how to develop sound working habits in workers, and how to supervise the workers as they developed. Only after they were thus prepared were they set to work. As a result of their teaching efforts the workers in due course accomplished remarkable results. Some more than doubled their production, others almost reduced their wastage to the vanishing point, while still others woke up sufficiently to win at least a classification among the average.

An interesting feature of the program was that which placed an entire department under instruction for a short period. After "the one best way" of performing each detail of the process in question was determined upon, all the workers were carefully instructed in its performance until correct habits were formed. They were well supervised as they developed in these habits and they were encouraged to do their utmost through the regular use of individual progress charts. After their working habits became fixed they acquired such dexterity as to increase their unit production at the end of the first month 98.5 per cent over their former average. With this was obtained a remarkably low unit labor cost, 43 per cent lower than before the instruction began. (See Fig. 3.)

FIG. 4 THREE STEPS IN ACQUIRING SKILL IN THE USE OF A TURRET LATHE

EDUCATION OF WORKERS WILL LOWER COSTS

This achievement is quite suggestive. It presents to managers a new thought for their program of lower costs, for the above results were obtained with a program which was well within the control of the factory manager and which proved of great benefit both to employer and workers. Other plants have accomplished similar results. They have all uncovered facts which showed that there had been much neglect in previous efforts to provide some medium for supplying operators with the instruction they needed to meet the full requirements of their jobs.

These companies no longer assign men to jobs immediately after they are engaged by the employment departments, but each man regardless of rank is first tested in the various requirements of the job for which he has applied. If he measures up to the standards of the job, he goes to work, but if he fails to do so, he is given special training in the particulars in which he is lacking. He is placed under the care of men who have been trained how to teach and develop good workmen and only after he has completed the required instruction and has proved his ability is he put to work. Through this process the men in the factory are made fit for their tasks and, having acquired the necessary intelligence, they fill out a balanced program which results in low cost of production.

While this departure from the common practice is not as well known to managers as it might be, there are indications that some of them are taking time to investigate such a program as an aid in their production plans. Some managers, however, have been alive to the situation and have endeavored to strengthen their organization in this respect, and the results they have achieved have encouraged them to still greater efforts and they have been an example for others. One such manager states that by definitely training his workers in the details of their jobs he has been able to obtain a much higher quality of work than formerly. His unit production has increased while his unit labor costs have dropped and, incidentally, he has increased the wages of his men. He has also reduced wastage and developed a fine spirit among his workers and it is evident that he has succeeded in well balancing the several elements of production.

Ordinarily an applicant for a job is passed upon by an employment clerk and if he appears satisfactory he is sent to the foreman. As a rule, however, the foreman is a busy individual especially in the early morning when new workers usually come to him, and his explanations are so brief and the worker is so distracted by his new surroundings that he absorbs very little of the instruction that is given. Foremen as a rule appreciate that they do not know how to teach. They say it is not their business to teach and they would prefer not to be interrupted in their task of getting out production.

TRAINING OF WORKERS A SLOW AND COSTLY PROCESS

Acquiring knowledge or skill in this casual manner is a slow and very expensive process and it usually

results in the worker contracting habits that actually handicap him in his later production work. He has no "one best way" to imitate and the meager instruction he receives is so fragmentary and disconnected that its effects are bad. The common failure to recognize the importance of this has contributed to the industrial world an army of undeveloped workmen and this handicap has had its effect upon production. The need for an extensive program along this line is evident, and applies to the small shop as well as to the large factory, as both are striving for the same goal of lower costs.

Many plants may be expected to feel that they are caring for the proper training of their men, and that while the suggested scheme may be desirable for others, they have little room for it in their own program. Such an attitude is a great handicap to a manager. Indeed, it places him in the same category with his workers who lack the necessary intelligence to do justice to their task and deliver a maximum result. Such managers need only take an inventory of the condition of their plants to determine whether or not correct working habits in the "one best way" of doing the various tasks are being properly developed and supervised. When this question has been put to managers they as a rule agree that no "one best way" has been decided upon, neither has consideration been given to correct working habits. In fact there has been no organized training, for those conducting the work were never trained to teach.

This brings us back to the starting point—our production failures are largely traceable to our neglect to give full recognition to the three fundamentals of production—materials, forces, and intelligence. We have overdone some and neglected others. Intelligence on the job can only be provided through the process of education. This implies teaching, and teaching in turn suggests suitable personality and proper training in teaching methods. Failure on the part of the management to consider these facts usually results in their selection of an "A-1 mechanic" or a "likable chap" as the one to teach workers and mould their working habits. Too many well meaning managers confuse personality with teaching ability. Yet the two are vastly different, although a pleasing personality is a valuable asset to an instructor.

THE EFFECTS OF POOR INSTRUCTION

Many examples may be cited of how lack of training methods has proved a detriment. One case may suffice. A large automobile factory with an ambitious program to cut unit labor costs provided at great expense an elaborate system under which every new worker was to be given a period of training before he was put on his job. Old workers whose production did not reach required standards were also to receive instruction in their operations and improve their output. The entire scheme, however, proved to be far from educational and though the men were kept busy by the instructors, the thought of developing correct working habits in them was apparently far from the minds of those in charge of the plan. Those workers most fit showed best results but as for the others, the program was "lots of fun" and the company paid for the "performance" in low production and high costs until it decided the scheme was a failure and it was abandoned.

The scheme failed largely because it was not developed by men who understood the art of teaching. The instructors were picked because they were "pretty good mechanics," but having received no training in their new task they were ignorant of the best method of imparting their trade knowledge to others and of showing others how to develop correct habits of work.

The factory manager who believes in the value of shop training for factory employees should determine for himself the fitness of those entrusted with the task

FIG. 5 GROUP INSTRUCTION ON AN ENGINE LATHE

of teaching others. Such instructors should be able to analyze a job and arrange its elements in best teaching order. They should be able, with the assistance of others, to determine the best way of performing each detail of a task, and they should compile a suitable method of instruction. Above all they should be skilled in the essential feature of their task, which is to impart their knowledge to others in the way that will best develop correct working habits. If they do not possess these essential qualifications their instruction is bound to be of a low grade. They should not be allowed to train others until they have received intensive training themselves.

Inquiry and investigation show that only in a small percentage of factories are competent instructors employed. Plant managers do not generally realize the advantages of instruction as a means of obtaining low unit labor cost. The results obtained in one plant, however, can be duplicated in another and managers who have reorganized their plans on this basis have been surprised at what can be accomplished when the

first essential for sound production, "intelligence in keeping with the job," is supplied where needed.

OLD WORKERS AS WELL AS NEW MUST BE INSTRUCTED

All this applies to old workers as well as to new. In our factories a large percentage of the operators who are below average are victims of the old practice of "breaking in" help. Their working habits are excellent examples of wrongly developed ones, and while such workers require longer and more patient training to break them of their bad habits, they can nevertheless be so improved upon as to accomplish much better results than at present. By giving these men a careful training the department output in several factories has been raised very noticeably and the unit production increased in some cases to 93 per cent.

The worker as a rule appreciates the value of the instruction and the consideration given to the development of his skill. When he is properly taught his interest quickly becomes aroused and his ambition to improve his skill and technique tends to create a further desire for knowledge. But aside from its effect on unit labor costs the results of such a training program are many. It greatly accelerates production, reduces wastage, and conserves time in the acquirement of skill. It also suggests to the management various ways in which minor difficulties may be overcome; and in the effort to decide upon the "one best way" of performing an operation many points are usually uncovered which contribute to the ultimate success of the main production program.

TRAINING BENEFITS THE WORKER

As examples of such conditions it was found in one case that a large number of time studies were "off," some as high as 54 per cent; in another it was decided to change the steps of the operation to those recommended by the training director, and this resulted in a considerable saving of time; in still another the inspection methods were so improved in the training department as to avoid an annoying "comeback" that had not only been a source of trouble but a great expense as well. In instructing workers whose output was poor in quality it was discovered that the poor quality was caused by a defective jig, the use of which had already spoiled several hundred dollars' worth of work. In another instance it was found that the large number of "seconds" was the result of a careless method of filing stencils used in making the product.

Such economies as these are not brought about without a corresponding benefit to the worker. High production directly increases his wages, while low wastage allows him to share in the quality bonus which is added to his weekly wage. The earning ability of many workers through this means is increased and brought up to a higher standard. Where training methods have been used to develop workmen the contribution of their "intelligence" to the production program is clearly seen in low unit labor costs.

Overtime *658.424*

The Influence of Overtime on Costs

By B. C. SLOAT

THE physician, finding in his patient a weakened heart action, often prescribes strychnine as a stimulant, and the plant manager or superintendent, to increase or stimulate production, orders overtime. But in either case, if the treatment be continued and the cause of weakness not found and removed, the ultimate result is the same—death or business failure. With the physician's patient, however, death is not due to the effect of strychnine on the heart action, but to its effect on the several interdependent functions of the organic system. Likewise in the industrial case, failure is not due to the cost of overtime on a single operation or in one department, but because of the increased cost throughout the correlated departments of the entire plant. So both the physician and the manager may use their stimulant, not as a cure, but only as a temporary expedient until through proper diagnosis the cause of weakness is found and removed by less destructive and less expensive methods.

In authorizing overtime it is but seldom that careful thought is given to the ultimate total cost that will ensue from its use. The authorization is usually given as a result of a suddenly discovered unbalanced departmental or component part production, or to meet an unlooked-for demand for seasonable goods, or for a particular style, brand, or unit of output. As a result of such conditions there is no time to consider any of the cost factors except the actual wage cost and that only in the departments immediately affected. The necessity and the spirit of "do it now" completely obscure the evil of the resultant high cost. It is also unquestionably true that under normal industrial conditions the use of overtime to increase production is frequently resorted to as the remedy for improper executive or administrative management.

WAGE COSTS AS INFLUENCED BY OVERTIME

The component cost factors influenced by overtime are many. The first factor is labor or wage cost. It is the most apparent and seemingly the most important factor, but in reality often the least, especially so when the period of overtime work is prolonged over several weeks. If when authorizing overtime the actual increase of labor costs in dollars and cents for the actual period of overtime were the limit of the increase in labor cost, then the increase would be justifiable in a large majority of cases. But this increase of labor costs during the period of overtime is seldom the true measure and it is because this fact is so often overlooked that troubles arise.

The fatigue factor and its cost are well known. It has been ably worked out, accurately measured, and is now generally given due consideration except in connection with overtime. And yet overtime causes greater fatigue than work done at any other time, and

its resulting evil—a lessened production rate on the part of the workman at an increased wage cost—is not only felt during the period of overtime, but for days after the working hours have again become normal. It will also often be found that until the workman has taken time off to recuperate physically and mentally, costs will increase because of idle machines or a disorganized force.

THE EFFECT OF OVERTIME ON SHOP MORALE

The effect of overtime work on force morale is more subtle. A decrease in the rate of production caused by a lowered morale cannot be measured by time studies. Because the management is not in close personal contact with the men, it cannot quickly sense the approaching overtime fever with its accompanying and costly industrial unrest. The foremen do not or dare not recognize and report it for they fear to be charged with the clock habit and having caught the fever attempt to overcome it by driving.

The causes of this unrest will not be openly discussed in the shop and honestly considered by the men and furthermore the increased wage has likely confused their opinions and, like children when overtired from play, they may entirely fail to recognize the source of their unrest. But, when conditions return to normal and the contents of the pay envelopes suddenly decrease, contagious and costly grumbling and discontent are apt to follow.

Another factor, the accident rate, will be found to have increased and with it the cost of accident compensation. To this cost must also be added the loss of time directly traceable to accidents and the decrease in production which results from fear of their occurrence. If seismographic charts of the effects of overtime on the workman's mind were possible there would more often be a reasoned "no" instead of a quick "yes" to a request for overtime.

WORKMANSHIP AND OVERTIME

Who, having been in charge of workmen during the extended overtime periods occasioned by the demands of war, has not asked himself with doubt: "Will the men work tonight? Will the 'gang' show up? And if they do show up, will they produce?" And how often did only partial gangs, in spite of specific promises, often grudgingly given, show up or stay on the job after the regular quitting time? What was the result? Broken gangs not only on the overtime, but on the regular day shifts; an unbalanced and a decreased rather than an increased total production; and a demoralized force to contend with when normal working hours and conditions were again resumed. Such a condition resulted of necessity in high labor turnover and the employment of a large force from which only partial production could be obtained. The recognition of the high cost resulting from the unrestricted use of overtime was an important industrial lesson of the war.

A far-reaching cost factor largely influenced by overtime is workmanship and it is a cost not readily segregated. Poor workmanship does not show up week by week as do the pay-roll totals. Nor does it show up, as truly influenced by overtime, in the production records, and except when flagrantly bad it may not show up as influenced by overtime for weeks or months. In fact in its true aspect it may never appear as a charge against overtime. Its results will come to light in the salvage pile; or they will be realized by the sales manager when orders are lost, are hard to obtain, or when customers complain that the usual standard has fallen and that goods of an inferior quality are taking the place of the old. "Our inspection will take care of quality," is the argument frequently put forth when the effects of overtime on workmanship are discussed. But will it? The same necessity that leads to overtime will be felt throughout the entire organization. It will go from the manager to the laborer on the floor of the shipping department. "We are working overtime to make deliveries." "This is a bit below standard but we must get out the work." "This will have to do this time." Such remarks are all too common. It is easy to let down but to build is difficult and costly, and there will be general faultfinding when inspection standards again become normal. A short period of overtime will increase costs for months due to the inevitable decrease in the standard of workmanship.

SHOP MAINTENANCE AS INFLUENCED BY OVERTIME

Two less important cost factors seldom given consideration in connection with overtime, but on both of which overtime has a decided effect, are tool depreciation and plant maintenance. Overtime will increase the depreciation and maintenance cost above the normal rate, owing to a decrease in the time normally given to the supervision of these items. This will be found to be especially true with motors and with heat-treating and forge furnaces. In these cases, and with line shafting and belting, the usual care given is often entirely eliminated or so hampered by the overtime production force that the necessary routine cleaning and minor repair work is delayed until an entire unit goes out for an enforced general overhaul. Small tool breakage and loss will also increase. Plant cleaning with overtime work going on must in many cases be so neglected as to decrease the production rate and few single conditions are so detrimental to morale as dirty floors, toilets, and basins, scattered tools, and full chip pans, or for the individual to find that he neglected to give his own machine its usual cleaning at the end of the previous day's work.

And so in conclusion we are forced to say that overtime, except it be employed as an emergency measure, does not pay, for overtimes increases wage costs, results in great fatigue to the worker, lowers shop morale, results in a low grade of workmanship, and it even leaves its effect upon shop maintenance and depreciation. Viewed, therefore, from any standpoint overtime cannot be regarded as of but little value.

The Essentials of Storeskeeping

By WALLACE CLARK and C. E. DAVIES

Respectively, Consulting Management Engineer, and Assistant Secretary, The American Society of Mechanical Engineers

IF a plant were surrounded by supply houses, which could deliver materials the moment they were needed; if the shop were so well equipped and organized that every manufactured part required would be ready exactly when wanted; and if the goods could be sold as soon as they were completed; then it would not be necessary to keep any stock of materials. However, it will never be possible to avoid delays in production unless reservoirs of material are maintained to insure an even flow of work through a plant.

The proper control of all materials in the storesrooms is of great interest to everyone concerned in a business. The owners or stockholders are interested because the amount of money invested in stores is frequently many times the value of land, buildings, and machines. The sales department is interested because it can sell only goods which are completed, and their completion depends on the raw material in stock. The workmen are interested for, if material is not at hand when they are ready to work on it, they must be idle, and continued idleness usually means no wages.

So when a man accepts the position of manager or superintendent of a manufacturing plant, since he shoulders the responsibility for getting work done in that plant he should first of all arrive at a clear understanding with the sales department as to:

1. What items are to be manufactured
2. In what quantities
3. At what time they are to be delivered.

When this program is fitted to the capacity of the plant, the manager makes sure that he has the right sort of men to operate the equipment and that his production engineering department issues the proper instructions to the shop as to the processes through which the material is to pass. The manager then purchases and keeps in his storesrooms the raw material and supplies needed for the manufacturing program. He also provides storesrooms and an organization to care for materials on which some work has been done and finished materials ready for sale.

In order to properly control his stores, the wise manager will select as a supervisor a man with an orderly mind, a capacity for detail, and the ability to get the best results from his men. He will also be sure that adequate methods are installed and used by his storeskeeper. By adequate methods is meant the proper arrangement of a storesroom, a scheme for regulating the ordering of material, and the maintenance of records in accord with the actual quantities in the storesroom.

Many storeskeepers who have grown up in a business think that their problem is so complicated and so peculiar to their own plant that it is impossible to adopt methods used in other places. This, however, is not true, for there are general principles which apply to storeskeeping of all kinds.

The First Step in Storeskeeping

First of all, in establishing a new department for keeping stores or in the reorganization of one which has been in operation, the manager determines what items shall be kept in stock. Most of the items to be placed on such a list are already available, but there will be many about which there will be a difference of opinion. These questions are decided by the management rather than by the storeskeeper. In taking up a specific item, one of the following courses is decided upon:

1. To purchase the item only when needed and not keep it in stock.
2. To manufacture on schedule.
3. To keep that item in stock.

1. The manager arranges for the storesroom to receive material which is not to be kept regularly in stock, and deliver it immediately to the department which ordered it. These items are usually called "unclassified stores," and in this case, the storesroom merely serves as a record keeper and distributor.

2. When an item is used in large quantities and assembled with other parts, it is possible to keep machines working on it all the time and maintain a fairly even flow of this part. This is called "manufacturing on schedule." There are times, however, when the flow of this material is interrupted by the breaking down of machines, the absence of men, or other causes; and it is, therefore, wise to maintain a small reservoir, i.e., to keep in a storesroom an amount which will meet the demand during a temporary interruption of production. This is usually only a few weeks' supply and sometimes only a few days.

3. The real task of the storeskeeper is in connection with the material which is to be kept in stock.

The Storeskeeper's Responsibilities

The manager makes it clear to his storeskeeper that it is his duty, as H. L. Gantt expressed it, "to have on hand when wanted all material needed." This is, of course, limited by the list of items to be kept in stock which the manager has approved. It is also necessary for the storeskeeper to bear in mind that an excessive amount of stock will tie up money which could be used to better advantage in other parts of the business. Fig. 3 showing an analysis of conditions in a plant where no stores policy existed, forcibly illus-

trates this point, for it shows that in some items there was less than a week's supply on hand while in others there was sufficient to last 80 years.

When the head storeskeeper accepts the responsibility for having material on hand when needed, he takes precautions to avoid running out of stock, and the success of his whole task of keeping stores depends on knowing when to order more. The "when" is determined, of course, by the time it will take to get a new supply. However, a record that an order must be placed two months before the supply of stock gives out will not help the storeskeeper to any great extent. This time must be translated into a quantity before it can be of any value. Accordingly the storeskeeper finds out how much material is likely to be called for during the time which intervenes between the placing of an order for more and the receipt of the new supply in his storesroom. He secures this information by going over available figures relating to past usage.

(From the practice of Walter N. Polakov)

FIG. 1 A PLACE WHERE STORES WERE "PUT"

The order point is a point in a diminishing stock of material at which consideration should be given to the ordering of an additional quantity.

When the storeskeeper has determined on an order point, he wants the reaching of it called to his attention. He has records kept in his office which show him the balance on hand at any time. Experience teaches him, however, that office records of stock which are not frequently checked with the material in the bins cannot be depended upon.

For years storeskeepers sought a danger signal which would be very nearly proof against errors; but it was not found until Gantt developed the idea of physically separating the amount comprising the order point from the other material and so marking it that no part of it could be issued without someone knowing that the ordering of an additional supply should be considered. The usage in any period is likely to differ from what it has been in the past, so it is not always necessary to place an order when this order point is reached, but it is necessary to bring the matter up for consideration.

MARKING THE ORDER POINTS

The physical separation of the order point should be so made that its violation will insure attention. The color, red, figures prominently in the scheme of separation.

The marking of order points can be done in a variety of ways. When an item of small size is stored, the order point is counted out, placed in the bottom of a bin and red boards are laid over it. The remainder of the order is placed on top. Where quantities are smaller, the order point is placed in a bag of red cloth or tied with red tape. In some cases, the order point is contained in wood or pasteboard boxes with red labels. In a roll of belting, the order point, measured in feet, is tied with red tape so that when that point is reached, the storeskeeper will be unable to unroll the belting further and will have forcibly called to his at-

(From the practice of Walter N. Polakov)

FIG. 2 A STOREROOM WHERE STORES ARE KEPT
Same space shown in Fig. 1

tention the placing of a new order. The same method is used in cable or wire reels. When storing quantities of liquid, tanks may be equipped with two valves, one of which can only be opened by a special key which must be secured from the head storeskeeper. The ingenious storeskeeper will find some way of separating the order point from other material in stock.

When the order point is reached, the storeskeeper sends the "order tag" (see Fig. 4) to the office after stamping on it the words, "order point reached." This scheme of physical separation in the hands of a well-trained storesroom staff will insure the prompt ordering of stock to be manufactured in the shop or purchased outside.

the shop running at its normal capacity, it would take about two months, from the time he placed a requisition for a new supply, until he received the parts in his storesroom. The head storeskeeper looked up his records and found that 24,000 of these parts had been used during the past year. The time of the order point was two months and the quantity, therefore, 4,000, i e., two months' normal usage. He counted out these 4,000 parts and placed them in one or more bins, placing red boards over these parts or across the front of the bins. Since then it has been impossible to take any of those parts without knowing that the order point has been broken.

When the storeskeeper is ready to place an order,

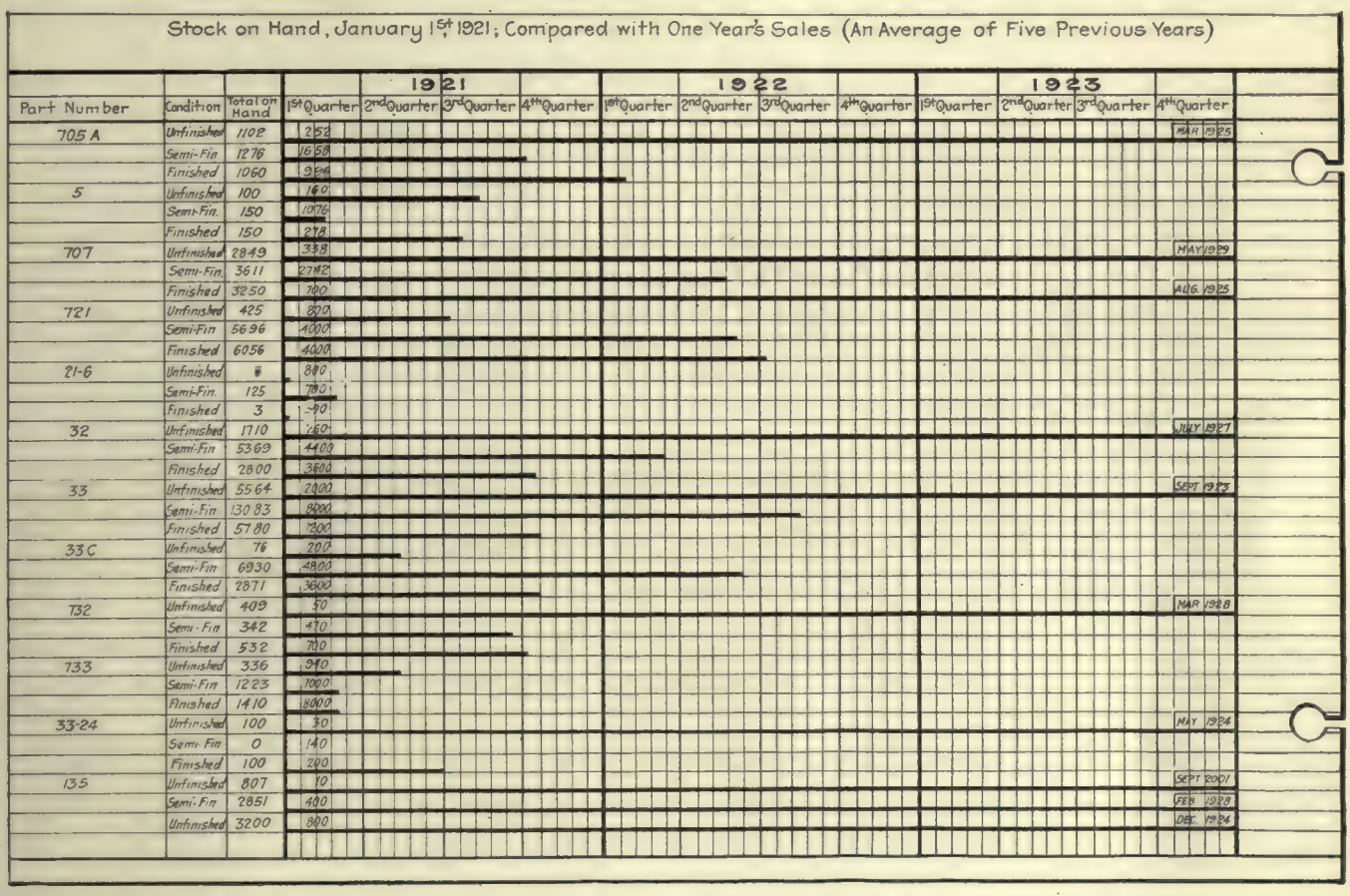


FIG. 3 CHART SHOWING UNBALANCED CONDITIONS OF STORES DUE TO LACK OF STORES POLICY

Of Part Number 33-24 no semi-finished pieces are in stock, but there is a sufficient supply of Part Number 135 to last at the present rate of consumption until September, 2001

The storeskeeper also has this order point marked at the top of the card on which he keeps a record of receipts and issues of each item. When the balance on hand is reduced to an amount equal to this order point, the balance clerk reports the fact to him. In this way, the matter is brought up both from his record and from the storesroom itself, and he has an opportunity to see whether or not his records agree with the facts. If they do not agree, he finds out the reason why and takes the necessary steps to avoid the recurrence of errors.

The following is an instance of the working out of this method. A manager decided that he would keep a certain machined part in stock. He found that, with

he must know the "amount to order." The manager has made a general ruling as to how much stock shall be kept on hand, i.e., how frequently he desires to turn over the money invested in materials; and if, for instance, it is decided that the investment should be turned over every four months, the storeskeeper places his order for the amount which he expects to be used in four months.

There are other factors, however, which need consideration. Every manufacturing order, whether large or small, which goes through a plant entails certain expenses, such as the clerical work of making out and following up an order, the moving of material, and the setting up of a machine. There is, therefore, a minimum

quantity which can be economically manufactured, and this may be in excess of the amount which would be used during the time decided upon as the best from the point of view of investment. This is also true of purchased material which can be secured at lower prices if quantities are bought which will last longer than the time of the desired turnover. This difficulty may be overcome by contracting for large quantities to be delivered on schedule.

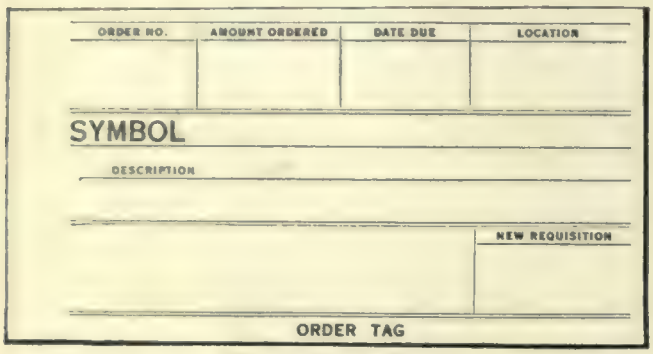


FIG. 4 ORDER TAG

Made out when order is placed and kept in bin to show when material may be expected. Size, 2 in. by 3¾ in.

When the storeskeeper has occasion to consider the buying or manufacturing of quantities which are in excess of the turnover decided upon, he will weigh the comparative advantages in dollars and cents of:

1. The savings due to purchasing in large quantities or the reduction of manufacturing cost by spreading the expense of set-up and handling materials over large quantities.
2. The clerical work of making out purchase or manufacturing orders, receiving material, paying bills, etc.,

as against:

(A) The interest on the amount invested.

(B) The rental and maintenance of the space in the storesroom which would be occupied by the material.

(C) The probability of the material becoming out of date.

When the storeskeeper has decided upon the proper amount to order, he sends his requisition to the manufacturing office or the purchasing agent. Every requisition states the date by which delivery is needed and gives clear specifications as drawn by the engineering department. This "amount to order" is written on the balance card (see Fig. 5) so that the next time an order is to be placed, it can be taken care of automatically without the necessity of another investigation. These balance cards are best kept in a card ledger desk such as is shown in Fig. 6.

The success of a storeskeeper is determined to a considerable extent by the promptness with which he issues materials and by the cost of operating the stores department. The arrangement of the racks and aisles should be such as to provide the shortest possible path from the receiving door to the racks and from the racks to the issuing window. The layout should also make the best possible use of daylight, although every part of the storesroom should be well provided with artificial light because the expense of lighting is low when compared with the cost of slow and inaccurate counting in a dark aisle and the difficulty of finding goods when wanted.

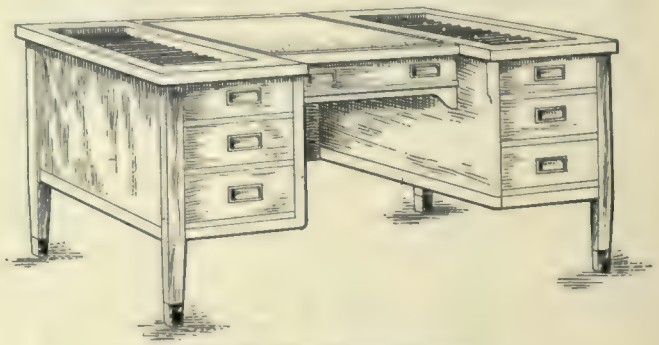


FIG. 6 CARD LEDGER DESK

A desk which keeps balance cards readily accesible

Experience also teaches the storeskeeper that the items he is to keep in stock will change continually and that he will never finish rearranging his bins. He, therefore, builds them so that it will be easy to move material without handling. Changes in the space required for any one item may be made without disturbing the whole system by the use of racks of standard dimensions and interchangeable bins, such as are shown in Figs. 7 and 8. These boxes are made in a variety of sizes in order to save space in storing parts which should be adjacent.

When parts are made in large quantities and moved in and out of the storesroom at a rapid rate, they are

							LOCATION	SYMBOL		
REQUIS. NO.	ORDER NUMBER	QUANTITY	DATE ORD.	DATE DUE	TIME NEEDED		ORDER POINT	AM'T TO ORDER		COST PER
RECEIPTS			ISSUES				ISSUES			
DATE	REC'D	TOTAL	DATE	ISSUED	CHARGE	BALANCE	DATE	ISSUED	CHARGE	BALANCE

FIG. 5 BALANCE CARD

One balance card should be used for the record of each order

most economically stored in tote boxes made to fit into the standard racks. Material is issued to the shop in these boxes, which are so built that they can be piled one on top of another without injuring the contents. Delicate parts and those requiring careful workmanship are handled in containers especially designed to protect them.

Having provided an arrangement of aisles which saves steps, and bins and racks which are interchangeable and save space, the man in charge of the storesroom keeps his aisles clear; his bins properly labelled (see Fig. 9); and materials neatly arranged in them. He takes great pains to get his counts correct, for small parts using counting scales which are more rapid and accurate than hand counts. Such scales are regularly and carefully inspected.

The cost of handling stores is inversely proportional

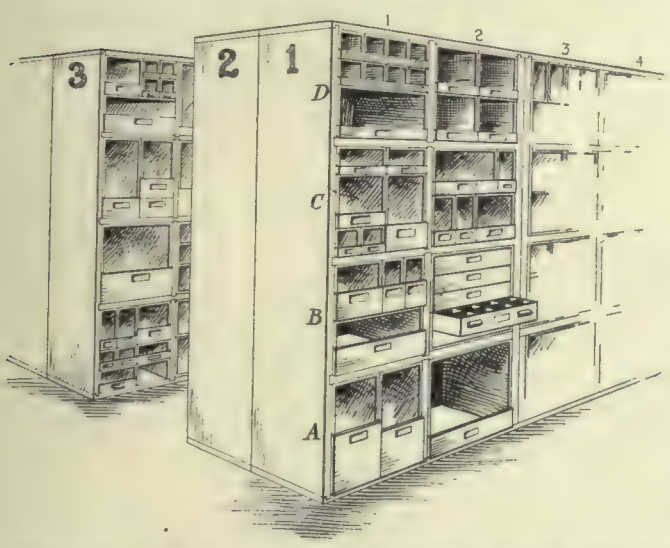


FIG. 7 RACKS OF STANDARD DIMENSIONS WITH INTERCHANGEABLE BOXES. SEE FIG. 8 FOR DETAILS

to the attention given by the management to the equipment of its storesrooms and the use of that equipment.

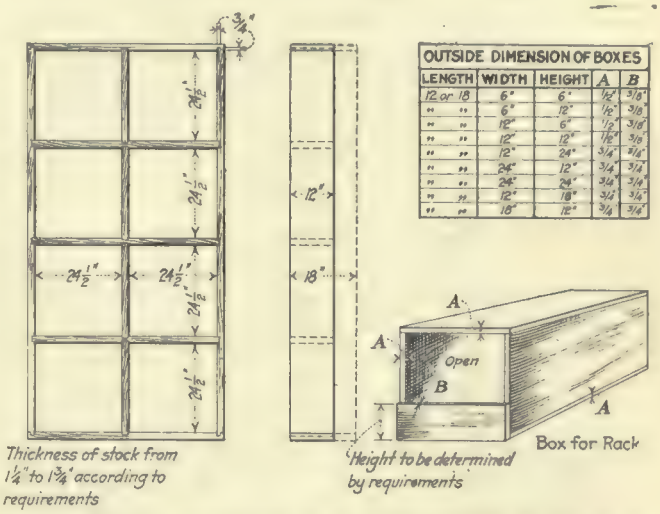
KEEPING RECORDS OF STOCK

The head storeskeeper keeps office records of stock for several reasons:

1. To help prevent running out of stock.
2. To know at all times what is in stock.
3. To know how much stock was received.
4. To know what has become of it.

The storeskeeper has a balance card (see Fig. 5), written out for each order placed. This card shows the name and symbol of the material, the order point, amount to order, price, etc. When material is issued from the storesroom, the "stores issue" (see Fig. 10) is obtained from the person to whom the material is given. The number of the order from which the material is drawn is written on this stores issue, which is then sent along with the list of material received to the balance desk (see Fig. 6). From these reports, entries of receipts and issues are made on the balance cards.

When the "balance available for use" gets down to the order point written on the upper part of the card, the balance clerk calls it to the attention of the head storeskeeper. If he has not been notified that the physical order point has been reached, the difference between the balance card and the material in the storesroom is investigated. If they agree, he places the order for the "amount to order."



OUTSIDE DIMENSION OF BOXES				
LENGTH	WIDTH	HEIGHT	A	B
12 or 18	6"	6"	1/2"	3/8"
" "	6"	12"	1/2"	3/8"
" "	12"	6"	1/2"	3/8"
" "	12"	12"	1/2"	3/8"
" "	12"	24"	3/4"	3/4"
" "	24"	12"	3/4"	3/4"
" "	24"	24"	3/4"	3/4"
" "	12"	18"	3/4"	3/4"
" "	18"	12"	3/4"	3/4"

FIG. 8 DETAIL DIMENSIONS OF STANDARD RACKS AND STANDARD BOXES

From the balance cards the following information can be secured for any item:

1. Dates and amounts received.
2. Balance on hand at any time.
3. Dates and order on which material is issued.
4. Value of material on hand.

From this record of past issues the future can be quite accurately foreseen.

Orders are kept separate in the storesroom. When the material on any order is used up, the balance card is also closed out, providing a second checking point between records and material in bins. The separation of orders in the storesroom has the additional advantage of compelling the use of the oldest orders first, to prevent deterioration. Accurate cost records are made possible by this physical separation of orders, the use of a balance card for each order, reports of receipts and issues showing order numbers and by entering on each stores issue the price shown on the balance card. The actual cost of material issued may then be posted to the cost of goods sold or used in the assembled product. This method makes it possible to trace material costs back from the completed cost record to the invoice for raw material and insures the recording of material costs at the prices actually paid.

SAFEGUARDING THE STORES

Another responsibility which the manager places upon the head storeskeeper is that of safeguarding the materials which are under his charge. The storeskeeper wants to remove temptation from the workman who sees in an open bin a wrench which he would like to have at home. In order to be sure that order points

are not broken without his knowledge, he must protect himself against the foreman or workman who, scorning what he calls red-tape, goes to the storesroom and takes material out of the bins to keep his machines running. He also wants to hold his assistants responsible for the accurate reporting of all materials received and issued. These ends cannot be accomplished unless the storeskeeper locks up his stores and places responsible people in charge of them.

In the operation of a storesroom, accuracy in handling material and maintaining records is a first req-

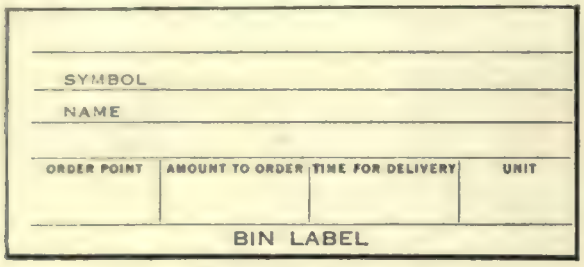


FIG. 9 BIN LABEL

An identification card for each bin held in standard sheet metal bin label holder. Size of form 1¼ in. by 3 in.

uisite. To insure this, the most satisfactory method is to assign a definite portion of the storesroom to each storeskeeper, and to hold him responsible for handling incoming and outgoing material in the portion assigned to him. In this way it is possible for one man to maintain correct records, such as bin tags, etc., and reports of stores issued and received in each subdivision. Responsibility for errors in counts is fixed and an individual accuracy record of each storeskeeper is built up.

An important element in the safeguarding of stores is the protection of materials from rust, dirt, and other forms of deterioration.

DISPOSING OF UNNEEDED MATERIAL

The necessity for making the best possible use of the space at his disposal also keeps before the head storeskeeper the problem of getting rid of material which is not often called for. At regular intervals he goes over his balance cards and notes the items which have not been used for a specified period, possibly six months. He has these items investigated by the sales and engineering departments and weighs the scrap value and the cost of storing against the cost of manufacture and the probability of their being called for at some future date. He usually finds that it is more economical to dispose of the material than to keep it.

SELECTION AND TRAINING OF PERSONNEL

The selection and training of the personnel of a storeskeeping department is of vital importance. The old idea that the storesroom is the place to put men who cannot make good in any other part of the shop, has been discarded. The head storeskeeper sees that each member of his organization is fitted for the work, thoroughly understands the routine of receiving and issuing material, and appreciates the importance of accuracy. When a mistake occurs, the storeskeeper attempts to find the reason for it and to take whatever steps may be necessary to avoid its recurrence. He discusses the matter with the individual who made the mistake, not with the idea of punishing him for what he has done in the past, but of increasing his interest in the work and his pride in the reputation of the storeskeeping department.

The salient points in the Gantt storeskeeping methods described above are the determination of the material to be stored, its order point and amount to order, the physical separation of the order point, the consideration of ordering when that point is reached, the use of balance cards for each order, the separation of orders in the stockroom, the checking of records with material,

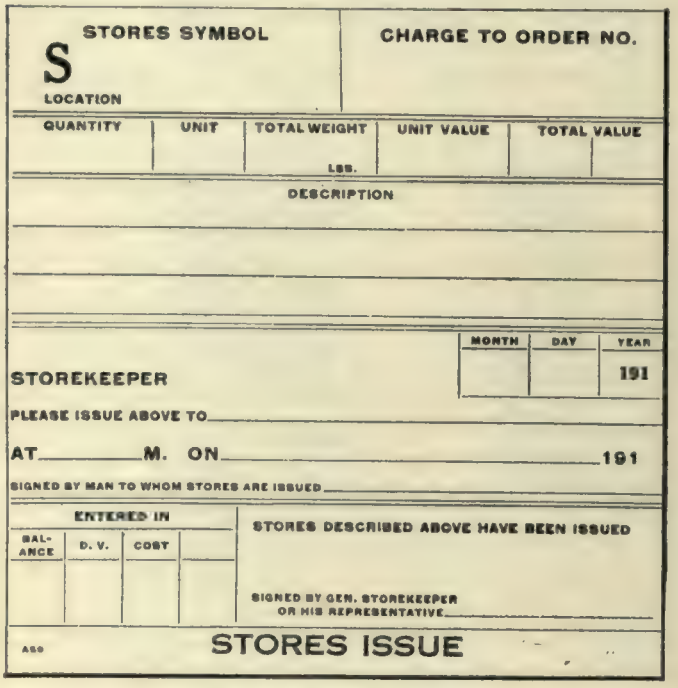


FIG. 9 STORES ISSUE FORM

An order or requisition for the issue of stores and a record of the stores issued. Size of form 4¼ in. by 4¼ in.

and the entering of the stores issue of the amount actually paid for material.

When a manager has organized a storeskeeping department in accordance with these methods, he finds that the time and money spent on the installation of methods, on improvements in arrangement and equipment, and in the securing and training of high-grade storeskeepers has been well worth while because of the reduction in the cost of handling and storing material and the elimination throughout the shop of delays due to lack of material.

However, the manager understands that such a storeskeeping mechanism and organization is not a substitute for business judgment. For instance, methods do not reduce an inventory on a falling market or increase it on a rising market. It is the business judgment carried out by means of these methods which reduces or increases an inventory. Such methods do induce an intelligent supervision of stock and provide a manager with the means of carrying out his decisions promptly and with certainty.

Woodworking industries. Management
Management engineering. Woodworking industries

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"Yield Value" Variations in Woodworking

How They Affect Profits Due to Sliding Scale of Lumber Values

By W. L. CHURCHILL

President, McDonald-Churchill Corporation, Industrial Engineers

THERE are many variations in the profits of woodworking industries, even where similar products are made under like conditions and sold at approximately or exactly the same prices. The usual explanation offered for this variation is "difference in management," but the conflicting results from different plants under the same general management indicate that the ultimate causes of the wide variations in net profits are something more elusive than difference in plant management, although of course the failure to discover the causes of unsatisfactory profits does ultimately reflect back to the general management of the enterprise.

Again, even where cost accounting systems have been introduced and developed in elaborate detail they often fail to disclose the causes for the tremendous differences in results for similar effort and energy, and apparently equal intelligence applied in the management of different enterprises. It is not uncommon, therefore, to find very efficiently managed and operated woodworking plants proving unprofitable, while other plants making a similar line of product prove extremely profitable despite apparent lack of general efficiency and even though obviously lesser intelligence has been employed in their management.

Although this condition is especially acute among woodworking industries it is not peculiar to them. Marked discrepancies between operating at a profit and operating at a loss are found in industries that work closest to the original raw material and in those that produce goods of wide range of values. Sawmills, veneer-mills, handle factories, and other industries, for instance, that depend on raw logs for their principal materials, especially if producing a wide variety of product, are notorious for the erratic and inconsistent nature of their profits. Industries using lumber and veneers as their principal material, especially if making a wide variety of styles or even of sizes of products, are likewise confronted with inexplicable differences in results from seemingly similar effort. On the other hand, industries purchasing their lumber parts in processed form are less affected by other causes than those directly attributable to the management—or lack of management.

FIG. 1 THE STORAGE YARD OF A MODERN SAWMILL

Lumber is no longer a cheap material, and management in the woodworking industry must therefore practice economies previously disregarded. Among these is orderly storage to prevent loss through damage and deterioration and to facilitate handling into and out of the yard storage piles.

Two underlying and fundamental causes are chiefly responsible for variations in results that are not plainly and obviously attributable to management. One cause, and the one that is most characteristic of the woodworking industry, is the failure to appreciate the differences in the "value of yield" from the raw materials, such as logs, lumber, bolts, flitches, veneers, etc. The other cause, and the one that is common to most enterprises making a varied line of products, is the faulty practice of adding profit to material costs in fixing selling prices; profits should be based on conversion costs regardless of material values.

What is meant by the term "value of yield" is the value in money of the different kinds, grades, sizes, and character of product obtained from any material the output of which can have variable values for the same quantity of product. A variety of possible products, having different commercial values, can be made from most natural raw materials and the raw material itself has a value equal to the sum of the commercial value of its constituent elements.

The various elements of mineral ores and crude oils, for example, are quite readily appraised, as they are more or less easily segregated and have definite com-

mercial values for each element. Coals and other mineral fuels can also be readily valued in accordance with their useful content. Likewise granite, marble,

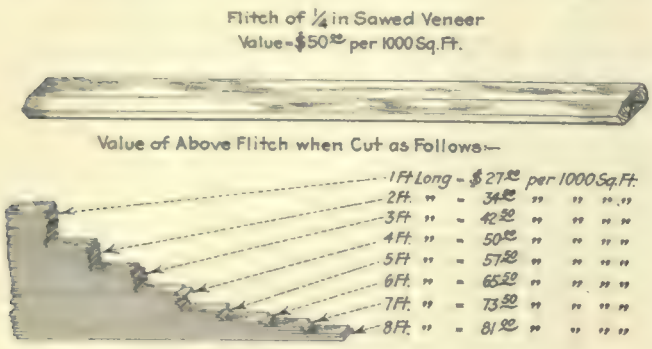
Flitch of ¼ in Sawed Veneer
Value-$50.00 per 1000 Sq. Ft.
Value of Above Flitch when Cut as Follows:—
1 Ft Long - $ 27.00 per 1000 Sq. Ft.
2 Ft. " - 34.00 " " " "
3 Ft. " - 42.00 " " " "
4 Ft. " - 50.00 " " " "
5 Ft. " - 57.00 " " " "
6 Ft. " - 65.00 " " " "
7 Ft. " - 73.00 " " " "
8 Ft. " - 81.00 " " " "

FIG. 2 "YIELD VALUE" VARIATIONS IN SAWED VENEER

and other building stones have varying value of yield according to appearance, size, and other characteristics that render them more or less valuable to purchasers.

THE VARYING VALUES OF LUMBER

Lumber has tremendously varying value not only according to different species of wood, but also within the limit of each species and variety, according to size, freedom from blemishes in appearance, and freedom from such defects as reduce structural value or proportion of yield. An Oregon pine stick suitable for a mast for a large vessel or for the support of aerial tramways, requiring extreme length and freedom from knots or other defects, has many times the value of the same amount of Oregon pine reduced to firewood, even though the latter may represent much more labor in its conversion into marketable form.

Lumber possesses a sliding scale of value whereby increases in length, breadth, or thickness increase the price per board foot, and the logging of lumber is the first place where careful observance of the value of yield can make for success or failure, regardless of the degree of operating efficiency with which the ground is "cut over." In other words, cutting a tree a foot or two lower on the stump than the most convenient height for such cut, in addition to the increase in lumber due to the added foot or two in length, may also put the resultant log into a class carrying a higher value per board foot because of increased length or average cross-section, thus increasing the value of yield beyond the added cost of felling.

Such increase in average value of yield may easily account for the greater profits earned by those operators who, while their general operating methods are inefficient, nevertheless obtain the utmost possible values from each tree cut down. A lower output per man may mean greater value of output per man, and explain why one operator succeeds where another fails even with better methods.

In the Florida forests, at the time when the railroads used wood on their locomotives, contractors would engage to clear the standing timber for prospective setlers and would cut this timber into suitable lengths for locomotive firewood to sell to the railroads. They would likewise cut the better logs into railway ties, thus obtaining two products, and, as the ties had greater value than the firewood, the contractors who by good judgment or good luck obtained the greater proportion of ties made the most money, since they secured greater value of yield.

In the converting of logs into lumber or into veneers, the concerns that strain all their efforts towards maximum total output, and fail to realize the maximum possible value of yield from their logs, can easily run

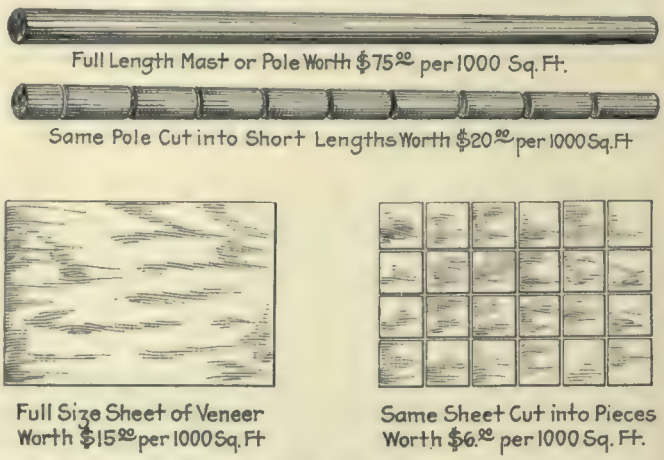
Full Length Mast or Pole Worth $75.00 per 1000 Sq. Ft.
Same Pole Cut into Short Lengths Worth $20.00 per 1000 Sq. Ft
Full Size Sheet of Veneer
Worth $15.00 per 1000 Sq. Ft
Same Sheet Cut into Pieces
Worth $6.00 per 1000 Sq. Ft.

FIG. 3 TWO EXAMPLES OF VARIATIONS IN "YIELD VALUES"

into unsatisfactory profits and even unaccountable losses. It is not merely a question of getting maximum proportion of salable lumber; it is also a question of getting maximum value from the logs.

SOME CAUSES OF VARYING VALUES

With the constantly increasing prices for lumber and lumber products, the differences in values for different sizes of lumber as well as different gradings become greater and more pronounced, and increased opportunity is offered for divergence in results. Cutting logs into boards of lesser value than such logs permit, sacrifices possible profits, even though the work of making such lumber is performed in the most efficient manner. Once the logs are cut, the chief opportunities to obtain maximum value of yield lie in obtaining maximum widths and thicknesses of the possible gradings, there being no opportunity to increase value through increasing lengths.

In the manufacture of veneers of the rotary-cut type, extreme variations in the value of yield are possible through variation in the length, width, and quality of material cut from a log. Some veneers have variations in values per thousand square feet of 6 to 1, or even greater between the largest sheets of desirable stock and the smallest marketable sizes of lowest grades of the same material. It is not uncommon, however, for veneer-mills to forfeit yield values for the sake of output. The temptations to do this are greater with ro-

tary veneer-mills than with slicing veneers, as the facility with which cutting spurs may be set to cut different lengths from the logs while turning makes it easy to cut lengths that may be readily salable and thus lose the greater values obtainable from maximum value of yield.

A Study of Yield Values

When an 18-ft. plank, for example, is cut into two 9-ft. lengths, the value is reduced, as an 18-ft. plank carries higher values than two 9-ft. planks. Also when a log 10 ft. long is cut into veneer in a rotary mill the yield value of its output is reduced with every reduction in length into which the product is cut. Five 2-ft. lengths are worth much less than two 5-ft. lengths.

Again two mills working together on the same material can obtain widely differing returns. The mill that spurs to obtain maximum possible sizes may make a great deal more money than the other mill that pushes for quantity of output and refuses to make sufficiently frequent changes in spur locations to insure maximum values from its output. The first mill may actually produce less material than the other and yet produce a greater value of material or yield. Few veneer-mills take this factor into sufficiently definite and important account. As careful a record of yield values should be kept as of volume of output.

A comparable industry is that of the shoe manufacturer. There is a wide variety of values in each hide, and shoe manufacturers are careful not to cut shoes from hides without careful comparison of yield values with prices paid for their hides. When veneer manufacturers become equally careful in following this procedure in regard to the output from logs, there will be fewer mysterious deficits in their industry.

As illustrating the wide range of possible values between different logs the following examples are quoted:

Log No 1 Containing 1000 Board Feet at $40

300 ft.	No. 1 Veneers at $150	$15
100 "	" 3 " " 60	6
100 "	" 5 " " 20	2
250 "	Crating " 12	3
250 "	Fuel " 8	2
1,000 ft.		$58

Log No. 2 Containing 1000 Board Feet at $40

100 ft.	No. 1 Veneers at $150	$15
200 "	" 3 " " 60	12
200 "	" 5 " " 20	4
250 "	Crating " 12	3
250 "	Fuel " 8	2
1,000 ft.		$36

It is, of course, appreciated that the yield from logs, lumber, veneers, etc., cannot be controlled beyond what may be originally in the material, but test runs show conclusively that the values to be obtained are controllable to a much greater degree than is generally believed. In this connection Figs. 2 and 3 are of interest as they graphically illustrate this very point.

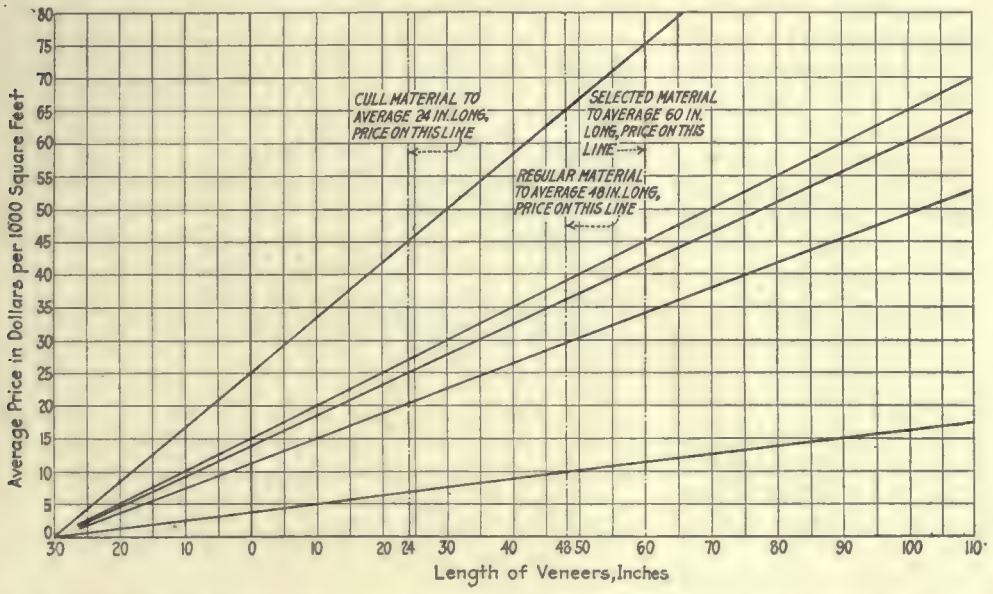
CULL MATERIAL TO AVERAGE 24 IN. LONG, PRICE ON THIS LINE
SELECTED MATERIAL TO AVERAGE 60 IN. LONG, PRICE ON THIS LINE
REGULAR MATERIAL TO AVERAGE 48 IN. LONG, PRICE ON THIS LINE
Average Price in Dollars per 1000 Square Feet
Length of Veneers, Inches
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80
30 20 10 0 10 20 24 30 40 48 50 60 70 80 90 100 110

FIG. 4 RELATION BETWEEN AVERAGE PRICE OF VENEER IN DOLLARS PER SQUARE FEET AND LENGTH OF VENEER IN INCHES

To determine the value of any length of veneer by means of the chart, take the price of the purchased material and refer to the vertical line corresponding to grade and the horizontal line corresponding to price. Next draw a sloping line through the intersection of the grade line and value lines with a focal point equal to 30 in. to the left of the zero on the horizontal scale. Along this line will be found the values of all lengths of stock obtained from this material.

In gluing up veneers for panels and furniture parts, the opportunities for losses due to failure to maximize yield are appalling. Valuable woods whose value increases with size can be cut into dimensions that make the resultant products cost more than can be obtained for the lumber. Woods which because of length and freedom from blemishes may be worth $500 per 1000 bd. ft. may be cut up into products whose over-all dimensions are such as could have been made from lumber costing only $300 or less per 1000 bd. ft. This same fact applies to other woodworking industries, but especially so to furniture manufacture where the practice of buying large, clear stock to facilitate manufacture was developed under conditions of cheaper lumbers.

With the increasing cost of lumber and improved methods for its machining, it is well to scrutinize all costs on a basis of the value of material in the product, comparing this value with the purchase price of the material, and to determine whether or not the saving in cost of manufacture resulting from the purchase of

lower grade stocks more than offsets their increased cost of conversion, not omitting the factor of effect on possible volume of output.

The manufacturers of leather products have as a rule established rather definite valuations for different portions of hides in different grades and sizes of leather, so that all users are in position to determine the value of their yield from any purchase of hides. Users of logs and lumber, veneers, and other wood products have not so generally formulated scales of values for sizes beyond certain grades and larger dimensions, thus making it less easy for them to determine value of yield from logs, lumber, and veneers except to a limited extent and classification.

THE DETERMINATION OF YIELD VALUES

To meet this situation in certain lines connected with production of furniture parts, and based on prices at which varying dimensions of lumber can be bought, the chart of Fig. 4 has been devised. Although no pretension is made that this scale is a correct one for all lumbers, it is suggested that it be reviewed in connection with other grades as possibly pointing out a rule or principle for guidance.

The scale of the chart was determined by first securing prices at which differing lengths of materials could be purchased and plotting lines through these prices. It was found that in each case, the zero value mark was touched at about 30 in. to the left of zero length, and as a working basis this point was adopted as a center from which to plot all lines. In test these worked out in reasonable coincidence with actual prices when due allowance was made for gradings.

In the matter of gradings, more or less abitrary standards were adopted. For example, "culls" was taken to mean material from which the lengths of usable stock would average 24 in., "selected" stock to mean stock whose usable lengths would average 60 in., and "regular" to mean stock averaging usable material 48 in. long. These definitions can be amplified to include any grade or description of log, lumber, or veneers, as will be obvious in considering the use to which the scale is put.

To determine the value of any length of material by means of the chart, first take the price and grading of purchased material and refer to the vertical line corresponding to grade and the horizontal line corresponding to price. Next draw a sloping line through the intersection of the grade line and value lines with a focal point equal to 30 in. to left of the zero on the horizontal scale. Along this line will then be found the values of all lengths of stock obtained from this material.

For example, assume that regular logs, lumber, or veneer are purchased at $30 per 1000 bd. ft. The chart shows a sloping line drawn through the intersection of the vertical line of 48-in. length (representing average length regular stock) and the horizontal line of $30 (representing the value of the stock). The sloping line shows that of this regular grade material purchased at $30 per 1000 bd. ft. a 6-in. length is worth only $14 per 1000, while an 84-in. length is worth $44. Also selected stock purchased at $38.50 per 1000 bd. ft. would be worth as much as regular stock purchased at $30 or cull stock purchased at $23; it would be simply a question of comparing yield with total purchase price.

For purposes of illustration, three different thicknesses of veneers cut from logs at $40 per 1000 bd. ft. are shown on the same basis and they indicate the variation in values due to differences in lengths of veneers cut from these logs in like manner. These illustrations show 1/20 in. regular veneer as worth $10 per 1000 sq. ft. when 48 in. long, and $13 per 1000 when 72 in. long, but only $5.60 when 12 in. long.

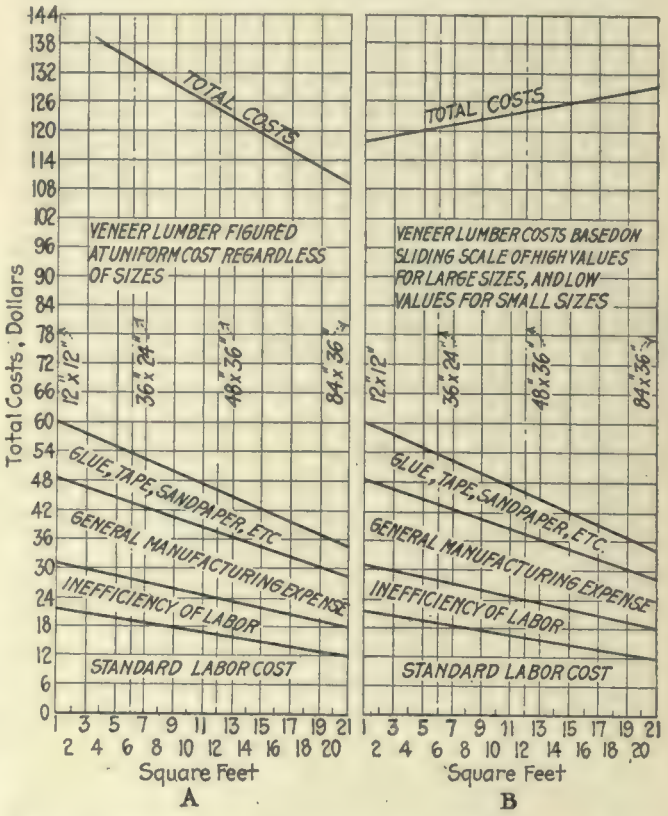

FIG. 5 COMPARISON OF METHODS FOR COMPUTING THE TOTAL COSTS OF VENEER LUMBER

Chart A. Veneer lumber costs figured uniformly regardless of sizes. Chart B. Veneer lumber costs based on sliding scale of high values for large sizes and low values for small sizes.

Fig. 4 also shows other sloping lines drawn for prices commonly used and obviously any price quoted for any grade gives the basis for determining values of all lengths obtained by drawing actual or imaginary lines to correspond with the quoted prices. Values are intended to mean actual purchase value and do not include cost of converting the material after receipt.

THE EFFECT OF YIELD VALUES ON COSTS

To illustrate the effect of using sliding scale values when computing costs of finished products, as com-

pared with using the average purchase prices for all lengths, Figs. 5 and 6 have been prepared. Chart A, Fig. 5, shows the total costs of glued-up veneered panels varying in dimensions from 12 in. by 12 in. to 84 in. long by 36 in. wide, computing lumber or veneer values in all sizes at average purchase prices. This shows total costs of the 12 in. by 12 in. panels as $143 per 1000 sq. ft. while the 84 in. by 36 in. panels cost only $108 per 1000 sq. ft.

In Chart B, Fig. 5, the same articles are shown, but figured on a basis of varying values for the different

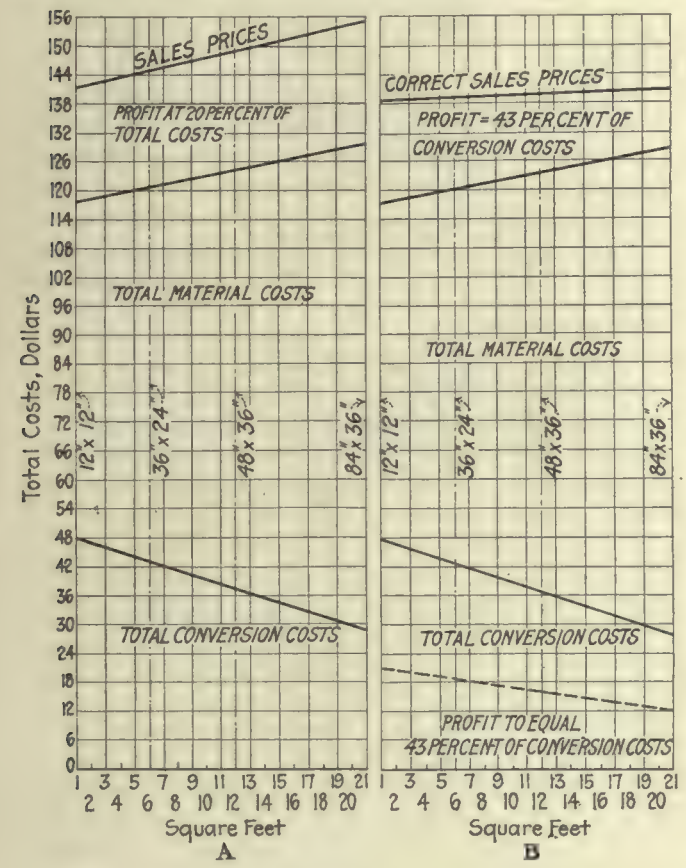

FIG. 6 COMPARISON OF CORRECT AND INCORRECT METHODS FOR COMPUTING SALES PRICES

Chart A. Sales prices based on material costs.
Chart B. Sales prices based on conversion costs.

lengths of lumber or veneer used. This illustration shows the 84 in. by 36 in. panel to have a total cost of $129 per 1000 sq. ft. which more nearly coincides with sales values. It is a well-known fact that the larger the material of this nature, the more people are willing to pay for it, and the smaller such material, the less can be obtained per square foot.

Veneer panels have been selected to illustrate this principle of yield values in costs on account of the large proportion of material cost to total cost. The extremely noticeable effect of this factor on this class of goods makes it a good example of its effect on all lumber products, variations being in degree but not in principle.

The factor of faulty "profiting" is illustrated to show the effect on income due to the almost universal practice of applying profits on a basis of a definite and fixed ratio to total costs. Profits should not be based on material costs but on cost of manufacture less the cost of materials, basing the latter on market values. By referring to Chart A, Fig. 6 (which is Chart B, Fig. 5, with an addition of 20 per cent for standard profit), and Chart B, Fig. 6 (which is the same cost chart with profit paralleling manufacturing cost less material), it will be seen that the selling price of a 12 by 12 panel is $140 per 1000 sq. ft., while for an 84 by 36 panel it is $155. That is, there is only a profit of 46 per cent of the conversion cost on a 12 by 12 panel while the 84 by 36 panel gives a profit of 135 per cent of conversion costs. In other words, if the total sales all ran to the small size, the total profits would be only one-third of those obtainable by selling the large size exclusively.

Likewise, as less expensive woods are used, with the same conversion cost, the possibilities of total profits become still less as long as profits are proportioned to total costs inclusive of materials; as more expensive woods are used the possible total profits become greater, except that prices for larger sized goods become so high that they automatically prevent large business.

Chart B, Fig. 6, illustrates the same average profit as Chart A, Fig. 6, but shows this profit proportioned to conversion cost only. From this chart it will be seen that the proper selling price for the 12 by 12 panel is $139 per 1000 sq. ft., and the 84 by 36 is $141.

THE ADVANTAGES OF CORRECT PROFITING

The principal advantage of this method of profiting is the control of total profits, thereby insuring the business against violent fluctuations due to changes in sales demand for varying styles, qualities, and sizes of product. As the standard of profit established should be understood as the minimum of profit to be obtained, there is nothing to hinder increasing this rate of profit on goods whose quality or scarcity justifies it.

The advantage accruing to the public from this method is that increases in cost of materials are not made more burdensome by inflation of profits. Conversely, as material prices drop the public only gains the actual lowering of material prices. The logic of this method is unassailable, as purchasers of manufactured products should not be expected to pay more than the open market price for the material in a purchased article, but should be expected merely to pay for the service of converting the materials into the desired products on a basis of the value of such services. That is to say, profits should be a service fee for the skill and ability to produce and the judgment and forethought to make available to customers such products as are required.

Manufacturers of wood products will greatly reduce the precariousness of their industries and insure more consistent and regular profits by looking after these two phases of cost and of profit determination. Costs should be based on variable material values due to sizes of stock in the finished product, and profits should be applied on a basis that eliminates consideration of material values from these profits.

Foremen *658.373*

The Training of Foremen

By P. L. BURKHARD

TRAINING is one of the foremost problems of management. The purpose of training is to educate, and the kind of education needed in industry is that which will enable men to accomplish more. In the shop the one man who most needs education is the department head. He usually recognizes the fact, and when given an opportunity and encouragement becomes an apt student of management problems.

In the past, foremen have been chosen for the most illogical reasons. Because a man is the most skilled operator of a drill-press it does not follow that he will be a good manager. Because a man has been in the employ of a concern for twenty yeas is no argument that he is a good leader of men. Nor is it always justice to the worker himself to make him an executive in the shop simply because of certain merits he may possess. It is true that men who have earned advancement should receive it; when promotion is deserved it should be given. But there is always a responsibility on the part of the manager when he appoints a foreman as well as a responsibility to be assumed by the appointee.

If the standards of foremanship are to be promoted the manager must accept the responsibility of his selection and see that his man makes a success of his new position. What is this responsibility? It is simply the responsibility of providing education, the responsibility of training the foreman how to be a good foreman. But before we take up the question of just what form of training should be provided for the foreman of an organization, let us ask ourselves of what a foreman's job consists. Of course, there are thousands of duties for which a foreman must account, but all his activities may be grouped into two main divisions.

THE DUTIES OF THE FOREMAN

In the first place a foreman should be the industrial engineer upon his own job and in his own department. This does not mean that there should be no other industrial engineers, either resident or retained, but it does mean that in addition to whatever consulting or managing influence may be attached to his position, the foreman should be firmly convinced of the correctness of the principles of industrial engineering, so that he may function in harmony with the general program.

In the second place the foreman should be an instructor himself. He should strive to become a leader, and in order to lead men successfully a foreman must needs be an instructor. This does not mean that the foreman must be a teacher of the subjects commonly taught in school, but merely that he should stand ready to interpret the plant policy to the men under him and thereby encourage co-operation to the fullest extent. To this end, he should inspire confidence and respect by his manner, his relations with the workers, and by his understanding of human nature.

Men who have made industrial engineering a profession have established the practice which should be the text material for foremanship classes. Their principles, therefore, should be recognized and practiced by the bosses within the plant as well as by engineers, and the extent to which these principles are applied will mark the degree of effective productivity secured and maintained.

For this reason the ideal training program is one which teaches how these principles are to be applied. The main heads under which the principles of industrial engineering fall may be put as follows:

(1) Purpose; (2) Data; (3) Standardization; (4) Planning; (5) Control; (6) Incentives; (7) Co-operation.

The first principle, purpose, brings the foreman face to face with the reasons for his own job. With this in mind he should contemplate the why and wherefor of his duties, their relations to other objectives, and his relation to the plant as a whole; the objectives for which the energy of the plant is being expended; and a means of industrial measurement by which all activity can be measured.

The second principle, data, embraces the procedure of the survey or investigation, the only means by which information may be secured; the analysis or diagnosis of the impressions and findings; timing in all its elements as a basis of establishing and verifying data; graphic presentation of data as a means of proving all contentions.

The third principle, standardization, has to do with four phases, all of which are essential in a well-organized and effectively operated plant—product, operations, conditions and instructions.

The fourth principle, planning, governs the disposition of the four elements of industrial activity with which we are all familiar: men, materials, machinery and methods. Every department head has it in his power to do at least some planning for the disposition of the four named elements, the extent to which he will plan, of course, depending upon the nature of control, either centralized or decentralized, under which the plant operates.

The fifth principle, control, consists in seeing that the plan adopted is executed. Every department head exercises control, yet few recognize the importance of a well-controlled production. Under this principle falls the movement of materials, the production of the product, inspection and maintenance.

The sixth principle, incentive, deals with wage payments, with the various forms of which, such as day work, piecework, bonus and premium plans, foremen should be acquainted, as this knowledge enables them to talk convincingly to their men of the fine points of their own system.

The seventh principle, co-operation, speaks for itself. Without co-operation effective productivity is an impossibility. No matter how well a plant may be designed and constructed, no matter how modern the equipment, and no matter how effectively the other six principles may have been applied, if men will not work together the result will be disappointment.

What is Management in Industry?

Placing the Blame and Fixing Responsibility

By C. E. KNOEPPEL

President, C. E. Knoeppel and Company, Inc.

WHEN the editor asked me to give him my idea of an answer to the question—"What is management in industry?" I felt that my views were sufficiently well crystallized to put them readily in writing, but it was only after a few quiet hours in my den that I fully realized there was much more to the question than I had thought. In a reflective attitude, and after a reminiscent journey through the "ins and outs" of a busy career, from laborer and moulder, to consultant in industrial engineering, I saw that my task was to point out, not what management is, but what it is *not*.

As I dreamed along in the silent processes of recalling and passing before my mind's eye the impressions of nearly twenty years, I discovered that I was really visualizing management from three different angles: first, as a worker; second, as a part of management; and third as a staff advisor to management.

An Arraignment of Management

Realizing the seriousness and the probable effect of what I am about to say, nevertheless my contacts with management from these three angles convince me that certain specific charges are in order, namely:

1. That 70 to 80 per cent of the inefficiency in industry has been due, and is now due, to the shortcomings of management.
2. That management has not realized, and does not now realize, that its shortcomings are the cause of our industrial inefficiency.
3. That management has not provided, and is not now providing, the wisest industrial leadership.
4. That management has not accepted, and is not now accepting, to the extent possible, the best staff advice obtainable on technical and managerial matters.
5. That management has not given, and does not now give, due consideration to the fact that it deals with efforts and human beings instead of materials and inanimate things.
6. That management has felt, and now feels, that workers, bankers, and politicians are responsible for the inefficiency of industry.

This I know is a bitter and vigorous arraignment of management, and by management I mean industrial executives from presidents to foremen; and as I said before I fully appreciate the significance of the charges and the possible extent of a backlash. But having thrown my "hat in the ring" it now becomes my task to demonstrate the soundness of these conclusions or, in other words, to take charge of the prosecution.

Granting that we may differ as regards the real and final purpose of industry, all will agree that it is the basic foundation of our civilized existence, and that the products of industry are the results of industrial activities, to the end that a complete life such as ours may be properly maintained.

What is the Product of Industry?

But in a larger sense the products of industry are not the physical things we see, like an automobile, a suit of clothes, a piano, or a box of candy, but the *time* of people; the hours and minutes of those from president to subordinates, foremen, workers, and laborers, whose joint efforts went into their making.

One may say that skill and effort go into the making of products. Quite so. But starting with a given time both skill and effort will decrease that time in proportion as they are separately applied, so that it may be said that time reflects both skill and effort. If workers, bankers, investors, executives, salesmen and users of all the products of industry will but visualize products as "time-composites" that is, simply as a sum total of hours and minutes reflecting skill and effort, a long step will have been taken toward common ground.

One may also say that a large part of what goes into a product of a plant is the material which it purchases. But what is that material? What does it represent? Is it not the hours and minutes of the respective plants that produce it? In the last analysis, therefore, is not any product a "time-result," even to the cutting of trees, the mining of copper or iron ore, the digging of coal, or the making of coke, or manufacturing brick? In other words is it not all human ability—skill and effort—measured in terms of 60 seconds to the minute, 60 minutes to the hour, and 24 hours to the day? Furthermore I care but little whether this time is consumed by a worker in a red shirt, an executive in a white collar, a laborer with calloused and dirty hands, or a clerk with well-kept fingers; for the fact still remains that production is the consumption of time necessary to convert ability into products, the same as coal is destroyed by burning, producing heat, and releasing gases and ash.

This is analogous to the principle of economics that consumption of goods is the destruction of wealth, and

the production of goods the creation of wealth. We make that we may destroy and we destroy that we may make, or to put it in another way, industry in its broadest sense deals in conversions, and in exchanges of abilities expressed as time reflecting both skill and effort. Because we cannot therefore economically convert a small ability into a large one, or exchange a thousand hours of work for a hundred hours of work of equal skill and effort, the element of "time conservation" affects industry as does no other one factor.

Conservation really means utilization to the fullest extent, and as the products of industry are "time-results" the matter of time utility is the greatest issue before this country today, especially when we appreciate that there can be mental and physical wastes as well as those of natural resources.

MANAGEMENT HAS FAILED TO UTILIZE TIME

Such reasoning leads to the statement of an important industrial principle around which hinges my entire discussion. It is this—*Time, which reflects skill and effort, is a composite industrial result, the efficiency of which is increased as time is conserved through inducing greater effort or intensifying skill.* Measured against this principle management cannot be said to have made the industrial success commensurate with its ability and its resources. The parable of the talents comes to mind in considering management as rendering an account of its stewardship, and this admonition seems in order:

> For unto everyone that hath shall be given, and he shall have abundance; but from him that hath not shall be taken away even that which he hath.

It behooves management to wake up! To conserve effort! To stabilize! To intensify skill!

The above has been written coldly and dispassionately from my viewpoint as an engineer, of nearly twenty years contact with management, a contact which has resulted in an experience which has helped me to appreciate management's responsibilities, its opportunities, its talents, and, most important of all, its shortcomings. It may be said that I am dealing in abstract philosophy, in high-sounding theories; but even granting for the sake of argument that it is philosophy and theory, is there anything fallacious about the fundamental concept? If not, then my statement regarding management's failure to measure up to its opportunities is all I need prove to vindicate my original contention.

I desire first of all to put before industrial executives this question: Have you conserved to the fullest extent possible the time of your mental and physical workers, the time use of your equipment, tools, and facilities, the time use of your floor space, the time use of your materials in stock and in process, and of the money invested by you and in you? If your answer is "Yes," how will you explain away the enormous wastes in industry which we all know exist? How will you justify yourselves in shifting the blame to other shoulders, and who will you acknowledge, then, as the real leaders in industry whose task it is to conserve? You cannot, of course, answer "No," without admitting the charges I made at the outset.

PLACING BLAME AND RESPONSIBILITY

And now having raised a reasonable doubt in your minds, I am going to make it easy for you to place blame and responsibility where it properly belongs. Turn for a moment to Tables 1, 2, and 3 and check the items indicated in the proper column where you think responsibility rests.

TABLE 1. INDUSTRIAL TOOLS, FACTORS, AND FACILITIES

Factors	Check Responsibility in Proper Column		
	Executives or Management	Workers	Investors or Bankers
1. Plant location			
2. Plant layout			
3. Selection of equipment			
4. Arrangement of equipment			
5. Maintenance of equipment			
6. Shapes and angles of tools			
7. Forging and grinding of tools			
8. Limits and tolerances			
9. Feeds and cuts			
10. Speeds of machines			
11. Jigs and fixtures			
12. Prints and specifications of product			
13. Interchangeability of product			
14. Standardization of product			
15. Adaptability of product			
16. Design of product			
17. Supply of material			
18. Movement of material			
19. Planning order of work			
20. Inspection			
21. Facilities furnished workers			
22. Working conditions			
23. Providing finance			
24. Building up organization			
25. Providing methods			
26. Selling product			
27. Providing foreman			
28. Engaging workers			

What do the tables reveal, now that they have been checked? Let us probe a little deeper. It is a law of physics that action and reaction are equal. Can this law be applied to industry? It would seem so after a study of Fig. 1, which shows the fluctuation in the production of pig-iron and paper for the 17 years from 1903 to 1919. The questions to answer after reviewing this chart are: Who is responsible for the fluctuations? Who pays for the idleness below normal? Who finances it?

It is obvious that severe losses must naturally accompany the producing of goods below normal. It is also obvious that when producing at or above normal, high prices must be secured to make up for the losses sustained at these low points. It can further be seen from this study that a condition such as pictured, which

spells an unstabilized condition in industry, can only mean instability in finance, as well as instability in labor.

My conviction, in fact my prophecy is, that labor is never going to be willing to do its full share in turning out quantity production and using labor-saving machinery to the fullest praticable extent until, through stabilization, we work normally in industry for longer periods, or more intensely, thereby reducing unemployment and seeking to equalize the excessive seasonal high and low demands for labor. And I cannot blame labor for its attitude.

To maintain the *Leviathan* in idleness in New York Harbor is costing our government $780,000 a year. What, then, must be the cost in industry yearly of idle machines, idle floor space, idle cars and locomotives, and idle workers, when operating below normal?

It is safe to say that the losses sustained below the normal line are sufficient to pay handsome profits and the highest wages if the swings could be eliminated.

If we produced pig-iron, coal, coke, plates, shapes, wire products, and other basic commodities in dull times, we would not have abnormally low prices, and

TABLE 2. KNOWLEDGE OF INDUSTRIAL ELEMENTS

Factors	Check Who Should Teach in Proper Column		
	Executives or Management	Workers	Investors or Bankers
1. Difficulties of financing			
2. Depreciation as an element of cost			
3. Overhead burden and its effect on costs			
4. Net profits, as distinct from gross profits			
5. Economical purchasing			
6. Effect of credit policies on bad debt losses			
7. Effect of seasonal demand on output and costs			
8. Effect of depression on business			
9. Overproduction			
10. Fear of labor saving machinery			
11. Supply and demand			
12. Inflation and deflation			

we would have these products when the demand came, without the abnormally high prices. What would happen if all the grain elevators and the cold-storage plants of the country should suddenly be destroyed? Or to put it another way: What is to prevent us from handling basic commodities the same as we handle the products we grow or raise and place in elevators and cold-storage plants?

Who Must Stabilize Industry?

Now, then, whose task is it to stabilize industry? Is it yours as industrial executives, or the task of the workers, or of the bankers? Surely the worker cannot be blamed for these things, for I myself know what it is, as a moulder, to go home in wet, dirty clothes, after losing my day's earnings through lack of training, or lack of proper direction, or lack of proper work-

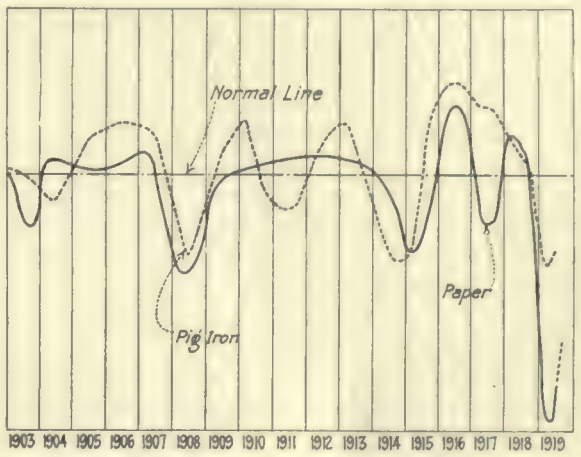

FIG. 1 THE INSTABILITY OF INDUSTRY AS SHOWN BY THE FLUCTUATION IN THE PRODUCTION OF PIG-IRON AND OF PAPER OVER A PERIOD OF 17 YEARS

ing conditions and facilities. Back in those years when I was earning my living with my hands, I made up my mind that a worker had a right to know three things:

1. What he was expected to do.
2. How long he ought to spend in doing it.
3. How much his earnings would be if he did it right and in the time set.

Who were my teachers in those days? My fellow workers and the leaders of those workers, and who else could I have looked to when I had no control or di-

TABLE 3. CAUSES OF INDUSTRIAL INEFFICIENCY

Cause	Check Who is Responsible in Proper Column		
	Executives or Management	Workers	Investors or Bankers
1. Idle equipment			
2. Unused floor space			
3. Faulty workmanship			
4. Defective materials			
5. Low production per hour			
6. Too much work in process			
7. Unbalanced inventories			
8. Too frequent changes in jobs			
9. High labor turnover			
10. Untrained workers			
11. Lack of hourly standards			
12. Not enough orders at times; too many at others			
13. Running out of material			
14. Fatigue of workers			

rection over the tools and facilities of production, when I was unfamiliar with the elements of sound business, and when I was uneducated as to the principles underlying commerce and finance?

Could I have looked to the owners of the business for enlightenment? No, because I distrusted them and doubted all their promises and my natural impulse was to fear them and this impulse was strengthened by the limitations and viewpoints of my mates.

Could I have looked to my foremen? No, because they scarcely knew more about such things than my fellow workers or I. Moreover, we could not blame a foreman for faults and shortcomings that were continued through no fault of his but which originated higher up and which he himself could not help.

It is perfectly natural that workers should first seek to obtain their education from within their own ranks. No influence is greater than the source of its authority, and influence in industry will therefore be from the worker upward or from the executive downward and it is going to mean a great deal to us in the future as regards the direction of this influence.

Can the investors or bankers be blamed for our industrial shortcomings? No, for they have no control over industrial activities in the way of direction. They work through a board of directors and executives. If on the board of directors, they act in advisory capacities, they formulate new plans and policies, they consider and vote for or against new proposals. But as directors, do they execute? Do they manage? If after leaving a directors' meeting, they actually carry out decisions of the directors, do they not do it as executives and not as directors? I am afraid management cannot brush the charges aside by a mere wave of the hand.

MANAGEMENT IS RESPONSIBLE FOR BUSINESS FAILURES

As additional evidence, however, showing what management is not, let me submit the reasons for failures as compiled by Bradstreet's. These are given as follows:

Incompetence	38.2 per cent.
Inexperience	5.6
Lack of capital	30.3
Unwise credits	1.3
Fraud	7.0
Failure of others	1.7
Extravagance	1.1
Neglect	1.7
Competition	1.1
Specific conditions	11.3
Speculation	0.7
Total	100.0 per cent

Incompetence and inexperience alone count for 43.8 per cent of the failures. If we add fraud, extravagance, neglect, and speculation, we have a total of 54.37 per cent, which can be directly traced to lack of ability, lack of education, or lack of experience, on the part of management. As regards lack of capital, case after case can be shown where wise and intelligent management has been able to secure ample financing. Money always goes where money can be made, the world over. This brings the total up to 84.67 per cent as being causes more or less within the control of management, and leaving 15.4 per cent of the causes beyond its control.

To give management a real conception of the possibilities ahead of it, as reflected by the extent of industrial inefficiency in this country, let us determine the factors in production and estimate their efficiencies.

There are four factors used in producing goods which can be reduced to a time basis, (1) workers, (2) machines, (3) plant as to duration and (4) materials. These are co-ordinated and used by or through industrial executives. Assume that the efficiency as to each is 50 per cent with a starting production of 100 units. Incease the workers' efficiency to 100 per cent and we will produce 200 units. Increase the machine efficiency to 100 per cent and we will produce 400 units. Increase the operation of the plant from 50 per cent to 100 per cent of its possible hours and we will produce 800 units. Increase the efficiency of material to 100 per cent and we will produce 1,600 units.

The starting production, 100 units, divided by the final production, 1600 units, equals 6.25 per cent, which shows that the final efficiency is not the *average* of the four efficiencies of 50 per cent each, but the product obtained by successively multiplying the four percentages.

WASTES REVEALED BY EFFICIENCY ESTIMATES

Table 4 is a statement of high, medium, and low efficiency estimates, and is worthy of careful study. From a study of the table it is apparent that whether productivity can be increased 164.5, 300.0, or 541.0 per cent, waste in all three cases is considered and equated as 100 per cent, which charges management with responsibility for industrial inefficiencies or waste to the extent of 67.6, 69.5, or 70.7 per cent, or in round figures 70 per cent. In preparing these figures it was considered that of the worker's inefficiency, one-half was within control and the other half within the control of management. Of the plant idleness, it was considered that one-half was caused by strikes within the control of the workers, and the other half due to lack of orders, within the control of management, as stabilization will mean more uniform orders and less unemployment.

From the figures above submitted the prosecution here states that management has not been an efficient co-ordinator; it has not been an industrial educator to the extent possible; it has not given us wise industrial leadership; it has not accepted the best staff advice obtainable; it has not properly planned the basis for efficient action; it has not supplied the best foremanship; it has not stabilized industry to the extent that must come; it has not provided solutions for industrial clash and warfare. Will labor unions do these things? Will employers' associations? Will bankers or investors? The answer is an obvious "No," for their viewpoint is restricted and one-sided.

But management sees all sides and works with all groups, therefore management should do these things,

can, and must do them, because it is best fitted to do so, from the standpoint of vision and constructive imagination, from training and experience, resources and facilities, and from opportunities which exist or which can be made. And yet unless management does actually take over the real direction of industrial affairs, and unless it provides the wise leadership necessary *some other group will.*

A PROGRAM FOR MANAGEMENT

But feeling confident that there is enough good sense, constructive vision, and executive ability in the ranks of management, to incline it to the first course, and realizing that this criticism should be constructive in its conclusion, let me outline in passing sentence upon management a program and plan of action.

1. Management should use the "looking glass" on itself, very carefully indeed, before deciding on any course of action.

2. Management should consider the logic of the assertion that troubles at the bottom are but a reflection of weaknesses at the top.

3. Management must realize that industry is not alone a profit-making and wage-paying mechanism, but a mechanism set up due to our progress through the ages, to serve the wants of mankind, and consequently a mechanism of service paying good profits and high wages.

4. Management must accept the advice and constructive plans of competent industrial engineers, as advisers and counselors to executives, because of their training and ability to reason and work things out in terms of causes, and effects of facts. In advising management in the future the engineer must become as great a factor as have been the banker and lawyer in the past.

5. Management must furnish a much wiser leadership in industry, because it is the logical and natural co-ordinator of the hour of the worker and the dollar of the investor. To do this it must prepare itself to qualify for this leadership by greater study of industrial matters and by acquiring the habit of looking at all sides of the industrial question.

6. Management must develop a plan of education which will give the workers a new and clear perspective, which will serve to disabuse their minds as regards the fallacies they now believe. To this end executives, and their neighbors who are executives, should hold informal meetings to which workmen should be invited. At these meetings there should be addresses by economists, engineers, big business men, and workers, using the "movies" wherever possible, especially in showing results and relationships in graphic form.

7. Management must also provide:
   - (*a*) Better organization which gives due consideration to directing, formulating, planning, serving and doing
   - (*b*) Knowledge of standard hourly productions
   - (*c*) Means of currently and graphically comparing actual hourly results with attainable standards
   - (*d*) Proper planning and routing of work
   - (*e*) Comprehensive and accurate cost data
   - (*f*) Standardized working conditions

TABLE 4. EXTENT OF AND RESPONSIBILITY FOR INDUSTRIAL INEFFICIENCY

ELEMENT	LOW ESTIMATE					MEDIUM ESTIMATE					HIGH ESTIMATE				
			RESPONSIBILITY					RESPONSIBILITY					RESPONSIBILITY		
	Efficiency Per Cent	Waste Per Cent	Calling Waste 100 Per Cent	Management	Men	Efficiency Per Cent	Waste Per Cent	Calling Waste 100 Per Cent	Management	Men	Efficiency Per Cent	Waste Per Cent	Calling Waste 100 Per Cent	Management	Men
Workers	50	50	34.5	17.2	17.3	60	40	34.8	17.4	17.4	70	30	35.3	17.6	17.7
Machines	60	40	27.6	27.6		70	30	26.1	26.1		80	20	23.5	23.5	
Plants as to Time Operated (Idleness due to strikes and no orders)	65	35	24.0	12.0	12.0	70	30	26.1	13.0	13.1	75	25	29.4	14.7	14.7
Material	80	20	13.9	13.9		85	15	13.0	13.0		90	10	11.8	11.8	
End Efficiency	15.6					25					37.8				
Waste	84.4					75					62.2				
Possible Efficiency	100					100					100				
Increase in Productivity if Possible Efficiency Could Be Reached	541.0					300.0					164.5				
Total of Wastes		145					115					85			
Equating Wastes to 100 Per Cent (Wastes ÷ Total of Wastes)			100					100					100		
Responsibility of Management and Men for Waste				70.7	29.3				69.5	30.5				67.6	32.4
Ratio of Responsibility as Between Management and Men				2.41	to 1				2.27	to 1				2.09	to 1

(*g*) Proper compensation in proportion to effort and skill

8. Management should consider advantages to be gained from such factors as:

(*a*) A research laboratory and a corps of experts to put in the best methods of manufacture
(*b*) A drafting-room for jigs, temples, special tools, and the like
(*c*) A field force to study what other manufacturers are doing
(*d*) A department to study industrial relations
(*e*) A department to study production rates, methods of planning and routing, what should be paid, bonus and incentive plans and the like.

9. Management must furnish a better degree of foremanship than it has; a trained foremanship, a foremanship made up of leaders, not drivers, who can inspire their following.

10. Management must also provide ways and means whereby workers can have a voice in discussing questions affecting their welfare. The particular plan chosen is less important than frank acceptance of this principle. Labor is becoming a factor of ever-increasing importance and is seeking a new status for itself. If management decides to "get back at labor," without regard to the new order of things, then management is in for trouble.

THE OPEN SHOP AND THE LABOR UNIONS

The open shop agitation is a modern industrial scarecrow and affects employers and labor leaders as the proverbial red rag does the bull.

If the open shop means an equal opportunity for a worker to sell his labor in the best market, without prejudice on the one hand or intimidation on the other, then it is squarely in line with sound public policy and as such the public is behind it solidly. But if it means discrimination by the employer against any worker who persists in his trade union membership, so long as the labor union policy remains clearly American, then such discrimination is unwarranted, un-American, and unsafe for industry.

If the labor unions propose to stand in an arbitrary manner behind the applicant when he seeks work; if labor proposes to force the employer to engage him regardless of his competency; if labor insists on standards of performance lower than can be demonstrated as attainable without injury to worker, then the shoe is on the other foot and the risk of insecurity and inefficiency of industry settles upon the shoulders of labor.

There is no doubt that among many employers the open shop means a closed and exclusively non-union shop. On the other hand there are scheming agitators manipulating honest workers for their own selfish ends, in demanding a strictly closed shop. Both terms are misnomers.

The right thinking employers and labor leaders want a "free" shop; free from intimidations, discriminations, abuse, incompetency, loafing, driving tactics, threats and destructive measures. They want a "wide open shop;" open to opportunity, to ability, to skill, to effort, to willingness to produce, and to bargaining in the best markets. And management had better take steps during 1921 to make its shops "free and wide open."

11. Management must determine and adopt ways and means to stabilize industry, to make the flow of work more uniform throughout the year, to get away from the high and low production peaks, thereby avoiding sharp price swings either upward or downward. In so doing it will do more to stabilize finance and labor than any other means will accomplish. In the manufacture of glass, candy, macaroni, and other diverse lines, stabilization has been worked out. It can be done with profit in other lines, especially as to stable and basic commodities. Storage space and financing will be necessary, but these were supplied in the case of grain elevators and cold-storage plants.

12. And finally, management must take steps to develop a scientific relation between costs and prices, for in most cases, there is no relation between costs and prices in industry as at present conducted. In too many cases, costs loaded with inefficiencies determine prices, whereas prices should reflect normal plant capacities, normal overheads, normal hourly productions, and normal profits. Management must provide the machinery for showing profits and losses due to volume, profits and losses due to purchases, as separate and distinct from profits and losses due to operation and selling.

The twelve points outlined constitute a real program indeed, but my study of the subject since thinking about and attempting to answer the editor's question, inclines me to the conviction that no single one of them can be ignored.

RESPONSIBILITY CANNOT BE SHIRKED

The pressing needs of the moment demand a full consideration of my charges, the arguments advanced to support them, and the constructive program advanced. What industry will be for a generation to come depends on what management does this year and next year. Its responsibility is an enormous one; one that simply must not be shirked.

In closing let me say this to the industrial executive: You are the "thinker in business," and leadership must come from those who can plan, organize, and put ideas into effective action. You are the one who can best influence the thoughts and actions of those under you, as they look to you for guidance, advice, counsel, and wise decisions. You are the only one to educate and train, because all the resources for so doing are in your hands. Disagree with me all you want to, but make this analysis serve as the basis for plotting the new course of management for the future, to the end that industry may be made efficient, stable, and productive.

Dare you do anything else than assume full responsibility for the conditions of tomorrow?

Cost accounting
Management engineering. Accounting

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What is Wrong With Cost Accounting?

Its Literature and Practice Have Little if Anything in the Nature of Definite Laws or Formulas

By G. CHARTER HARRISON

Consulting Accountant

ATTENTION has often been drawn by accountants and others to the failure of a large percentage of manufacturers to adopt the methods of cost accounting approved by the majority of professional accountants, but as far as the writer knows these criticisms invariably have been directed at the manufacturer and not at cost methods themselves. It does not seem to have occurred to these critics that if a large body of intelligent and practical men consistently refuse to introduce the recognized methods of cost accounting, this refusal may be due not to a lack of progressiveness but to a deliberate judgment that the advantages to be gained from these methods are not of sufficient value to offset the expense of their acquirement.

That the failure of many manufacturers to introduce complete systems of cost accounting along the lines approved by the accounting profession is due to design rather than negligence would seem to be a reasonable supposition, for in general the average manufacturer is willing enough to spend money for innovations if he is fairly well satisfied that he will obtain an adequate return from his investment. In many cases he has cautiously waited to see the result of cost experiments in a neighboring factory and often after noting the considerable number of clerks required to maintain the new cost system has concluded that it would have to be a very remarkable system indeed to produce savings sufficient to offset the resultant increase in the pay-roll. He usually decides, therefore, to spend his money on something from which he is more certain of receiving a substantial return.

The Purpose of Business

Accountants are liable to overlook the fact that a manufacturer is in business for the primary purpose of making money, and as a matter of fact the advocate of the usual systems of cost accounting would have difficulty in proving to a manufacturer that expenditure in a cost system would, without question, turn out to be a profitable investment. He may urge, for instance, that by obtaining information as to which lines are profitable and which unprofitable the manufacturer will be able to keep the cream of the business for himself and leave the skimmed milk to his competitors, forgetting that it may be necessary for the manufacturer to carry a complete line in order to satisfy the requirements of his customers. The accountant may enlarge on the value of cost information as a basis for setting prices, but may be met with the statement that competition requires the manufacturer to meet prices regardless of what the records show his costs to be.

The Defects of Present Methods of Accounting

Perhaps the best indication that there is something wrong with the usual methods of cost accounting is the fact that many large concerns whose cost methods are strictly in accordance with those advocated in standard works on the subject are beginning seriously to question whether these methods meet the requirements which should be demanded of a cost system. Recently the writer was present at a discussion between the general works manager and the chief cost accountant of a machine manufacturing concern whose name is a household word and whose cost methods would be regarded by many a professional accountant as the acme of perfection. The cost system maintained by the concern in question provides accurate monthly information as to the cost of every part, assembly, and machine manufactured, and as to the profit and loss made on each kind of machine sold during the month; and yet the general works manager was so dissatisfied with the results obtained that he was considering the adoption of a subsidiary cost system entirely independent of the official cost system maintained by the accounting division.

In a discussion with his chief cost accountant he expressed himself very strongly as to the lack of practical value in detailed cost data presented fifteen days after the end of the month; he drew attention to the absurdity of calling foremen to account for events which happened four or five weeks previously; he mentioned the fact that the operating division had set a cost standard for a certain new and important item of product and wished to know whether the cost department could advise him each day as to the variances from the standard cost of this article during the day previous. In view of the fact that the article in question involved the performance of several thousand operations and the cost system in force was designed with the sole purpose of showing the actual costs of finished machines monthly without reference to standards, the chief cost accountant very properly

stated that to give this information daily would be a practical impossibility under the existing plan.

Theodore Roosevelt once stated that nine-tenths of wisdom consists of being wise in time, and it can hardly be contended that the demand of the general works manager for information as to where the costs in the day previous had exceeded the standards was an unreasonable one; yet there is probably not one cost system in a thousand under which this requirement could be met. In the cost system which was being discussed, actual cost data were shown without relation to standards, and, therefore, even the monthly costs of the assemblies and machines had little significance considered as a gage of efficiency. Nevertheless, this cost system is typical of the cost methods advocated in standard works on cost accounting, recommended and designed by professional cost accountants and practiced by large manufacturing concerns.

Obviously, when cost methods do not meet the requirements of progressive works managers something is radically wrong, for in the final analysis the operating man is the one whom the cost accountant will have to satisfy and at the present time there is no question but that the accountant has failed hopelessly to meet the demands made upon him.

In another case with which the writer was familiar very large contracts were taken, the bids submitted being based upon careful cost estimates made by the superintendent. Although the cost system in force was most elaborate and expensive, the superintendent was not able to obtain information as to whether his costs conformed to his estimates until after the completion of the contract when, obviously, the information would be received too late to be of much use. Accordingly in desperation he devised and installed a system of his own from which he was able to obtain each day information as to where his costs had exceeded standard and was thus able to control the cost of the work from the start to the finish of the contract. When the writer drew the attention of the chief cost accountant to the valuable results obtained from the superintendent's subsidiary cost plan the only comment made was to the effect that the superintendent should be disciplined for encroaching on the cost department's territory.

Changing Views of Cost Accountants

All accountants, however, are not so narrow as the one just referred to, and the writer remembers a short time ago the comptroller of a very large concern expressing himself somewhat as follows:

"We have been operating a cost system which we have been told repeatedly was unusually efficient. We receive hundreds of orders in a month and yet our system will enable us at reasonable expense to determine the profit or loss which we make on every order. After operating this system for many years, however, I have come to the conclusion that it must be regarded as a failure, for it does not give our operating men what they really need and that is information as to inefficiencies. We tell them what it costs to manufacture our product but we do not tell them where their costs are excessive and why they are excessive and I consider that until we do give them this information our cost system cannot be considered as meeting the obligations of my department."

From all this it is evident that the cost accountant is on the verge of making an unpleasant discovery. His position is similar to that of the traveler in whose mind the suspicion that he is on the wrong road has been growing stronger with each mile, in fact has almost developed into a certainty, and who is faced with the bitter fact not only that he has made no headway but also that he will have to retrace much of the distance already traversed.

This is a realization, however, which has to come, and the longer it is postponed the more tragic the awakening. Hence the most hopeful feature of the cost-accounting situation today lies in the completeness of the failure of the cost accountant to meet the needs of the industrial world. Conservatism is the dominant trait of the accountant, and nothing short of total failure would be sufficient to drive him to the wholesale scrapping of traditional ideas and methods which is the necessary first step towards getting cost accounting on a fundamentally correct basis.

Accountant's Failure to Supply Information

Engaged as he has been in the congenial task of disclosing the mote in the eye of the operating man the cost accountant has failed to perceive the beam in his own, though the engineering profession for the past ten years or so has rather consistently expressed itself in no uncertain terms on the failure of cost accounting to keep pace with industry in general. The main results of these criticisms have been a growing sense of irritation on the part of the accountant as to what he regards as an unwarranted encroachment on his territory, and a widening of the breach between the accountant and the engineer.

There are of course cost accountants who will affirm that nothing is the matter with cost accounting and that the methods of cost accounting adopted by the average manufacturing concern under which detailed cost and profit and loss data are compiled monthly are capable of meeting all reasonable requirements. The best proof, however, that these methods do not meet the needs of the operating man is the fact that in large plants it is the rule rather than the exception to find that a subsidiary cost system is operated for the sole purpose of furnishing the works manager with cost information which he cannot obtain from the official cost system.

The lot of the cost accountant of today is by no means a happy one, for in a plant where progressive manufacturing methods are employed he is engaged in one long, hopeless struggle to meet demands for information through the medium of a cost plan which is no more adapted to modern conditions than a system of horse-cars would be to meet the transportation needs of New York City. He endeavors to meet the demands made upon him by introducing little subsidiary plans

and contrivances with the indifferent results which usually follow such makeshift methods.

Something is radically wrong with cost accounting and it should be kept in mind that basic defects cannot be corrected by tinkering with surface details. It therefore behooves the accounting profession to relinquish endless theoretical discussions concerning such matters as whether interest should be included in costs or not, and getting down to fundamentals determine what is the underlying reason why the cost methods of today do not meet the requirements of the operating man. He is the one whose requirements must be met by cost accounting.

PRESENT COST ACCOUNTING UNSCIENTIFIC

Many years ago the writer entered into one of those peculiar English agreements under which, in return for the payment of a substantial premium, he was given the privilege of serving an apprenticeship of five years during which period he received as salary an amount equal to one-half of the premium paid. During the term of his five years' apprenticeship the writer's services were charged to unfortunate clients at rates varying from seven-and-a-half to ten dollars a day and altogether the arrangement was a distinctly advantageous one to the other party to the agreement. In one of the clauses of that agreement it was stated that in return for the investment made and the services given the writer was to be fully instructed in what was grandiloquently termed "the science of accounting." In this phrase lies the whole cost accounting problem, for the basic trouble with cost accounting is that it is masquerading as a science whereas in fact it has no claim to be considered scientific in the slightest degree.

The logical method to determine the correctness or incorrectness of the writer's assertion that the commonly accepted methods of cost accounting are not based on a scientific foundation would seem to be: (1) to establish what the essentials of science are, and (2) to consider whether cost accounting methods generally conform to these requirements.

WHAT IS SCIENTIFIC KNOWLEDGE?

The word "scientific" is derived from the Latin verb *scire*, "to know," and in the sense in which it is generally used embraces the conception of all co-ordinated, arranged, and systematized knowledge. The term as employed by scientists, however, is given a more restricted significance, as for instance, in the definition given by John Stuart Mill, as follows:

> Since all phenomena which have been sufficiently examined are found to take place with regularity, each having certain fixed conditions, positive and negative, on the occurrence of which it invariably happens, mankind has been enabled to ascertain the conditions of the occurrence of many phenomena; and the process of science mainly consists in ascertaining these conditions.

The universe is subject to the operation of immutable physical laws, so that if a certain combination of conditions at one time produces a certain result a recurrence of these conditions at a later time will inevitably duplicate the phenomena previously obtained. It is on this fact that science is based and its practical value founded.

If the wide field of present-day scientific knowledge is surveyed, it will be found that in all its branches the laborious experiments and observations made by scientific investigators have been concentrated in laws and formulas. Formulas represent the fabric of the scientific edifice. The results of a lifetime or many lifetimes are expressed in a single, brief generalization, and each investigator who establishes such a generalization or formula adds a stone for his successors to build upon and carry along the work from the place at which he left off.

As a matter of fact little progress is made in any science until definite principles are laid down and generalizations established. For instance, no definite progress was made in the study of etymology until Jacob Grimm formulated the well-known Grimm's law. Progress was likewise slow in electrical science until Ohm propounded his important law giving an expression for the strength of an electrical current, or the quantity of electricity passing in a given time under certain conditions; nor was much progress made in astronomy until Sir Isaac Newton formulated the law of gravitation. In political economy we find basic generalizations expressed in Gersham's law, as "bad money drives out good;" and even in so subtle a science as that of psychophysics we have such definite formulas as Fechner's mathematical law that the force of stimulus or excitation increases geometrically while the intensity of sensation increases arithmetically, thus bearing out the philosopher Kant's dictum that any branch of knowledge contains just as much science as mathematics.

The tremendous value of scientific methods is well illustrated in the extraordinary advance which has been made in the field of radio engineering. In 1893, Sir William Crookes suggested that electric waves could be utilized for the transmission of messages through the ether, and between 1894 and 1896 Marconi proved the correctness of the theories to such a point that by 1898 it was possible to send messages between stations 14½ miles apart. Nowadays we have trans-oceanic receiving stations equipped with dictaphone receivers which are so arranged that, immediately one wax record is indented with signals, a second dictaphone record is automatically connected in the circuit, and so on. The use of these records permits traffic to be dispatched across the ocean at the rate of 75 words a minute, the records being then transcribed on a typewriter at speed varying from 30 to 40 words a minute. Surely this is a wonderful advance in less than 22 years.

THE SLOW PROGRESS OF COST ACCOUNTING

Can it be claimed that cost accounting has made an advance in the last twenty-five years in any way comparable to that accomplished in the field of radio engineering or of other branches of scientific work? In any really important respect are the commonly accepted methods of cost accounting different from those which were laid down by Garcke and Fells in the early

eighties? It is true, of course, that improvements have been made in the methods of burden distribution, and particularly in the application of accounting machinery in the routine work of cost compilation; but, considered broadly, these are matters of minor significance.

THE NEED OF THE PRESENT

The troubles of the cost accountant today, therefore, are due to the fact that he has no scientific foundation on which to build; he is an historian, not a scientist. The present trend of manufacturing is towards the future as opposed to the retrospective methods of the past. The complexity of modern manufacturing, the multitude of its parts and operations, make it absolutely necessary that every step in the long chain of manufacturing processes should be predetermined and planned-for in advance.

That form of cost accounting which views costs in the retrospective sense solely, which does not consider costs in relation to standards and is not concerned with determining the causes underlying cost variation, is hopelessly at variance with the prospective trend of modern industrial thought. No real progress will be made till the accounting profession awakens to the fact that, like Rip Van Winkle, it has been asleep for twenty years.

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An Unsolved Management Problem

By L. W. WALLACE

Executive Secretary, American Engineering Council

WE are very prone to believe that there are no unsolved problems of engineering and management. This thought frequently prevails among college students and recent graduates; and it is unfortunate, for such a thought reduces ambition and curtails inspiration. It has, moreover, been the writer's observation that there are an unlimited number of unsolved problems of great magnitude. Sometimes a pang of regret flows through him because there is neither time nor opportunity for attacking some of the essential and fine things to be done and that are all about. No young engineer or engineering student should long seek for something worth while to which to devote his best efforts because the world is waiting for qualified, earnest and public spirited engineers to solve some of its most difficult problems.

In recent years, for instance, decided progress has been made in controlling production factors, yet the degree of refinement and the scope of application possible by no means have been exhausted. In any plant congested areas, idle equipment and labor are to be observed. The productive possibilities have not been realized in many plants. Authorities quite agree that few plants produce more than 70 per cent of the possible and many plants have a productive effectiveness of only 25 or 30 per cent.

From an address given April 1, 1921, at New York before a joint meeting of the Metropolitan Student Branch of the Am. Soc. M. E., the Society's Metropolitan Section and Professional Division on Management.

How to bring the plants that are realizing only a 25 or a 30 per cent production up to even 70 or 80 per cent, is not known. There are many angles to the problem—capitalization, competent personnel, plant location, plant equipment and management, and other factors that must be considered. We know a good deal about many of these things—indeed information may be available whereby one may solve any and all phases of the problem. But this information has not been adequately codified, correlated or disseminated—so that the industrial mass knows of it and comprehends its importance. How the material to be assimilated and the facts to be disseminated and the industrialist to be taught to appreciate its value and the necessity for using it—is yet to be answered.

The Federal Trade Commission has told us that about 90 per cent of all industrial and commercial firms do not know what their costs are. As a result, there is unfair and destroying competition. Not knowing costs, the reason for the loss of or the absence of profits leads to a wrong conclusion as to the cause. This absence of correct knowledge of known causes results in improper measures being adopted to remedy the apparent losses, the result being that often more harm follows. In this, alone, rests one of the greatest economic wastes of industry. How to instruct plant managers so they will have a full comprehension of the importance of and the essentialness of an adequate cost control system, is one of the unsolved problems of industry of great magnitude. There is adequate information to be had and machinery to be used—but to arouse enthusiasm for its application is the problem.

A STANDARD TERMINOLOGY NEEDED

In the past months the writer has been directing the work of the Committee on Elimination of Waste in Industry. This Committee is working under the auspices of The Federated American Engineering Societies and was appointed by Mr. Hoover. This study, this endeavor, has called to mind a very large number of problems that are yet unsolved. It is surprising that some have not been answered. For instance, in the matter of terminology we are speaking in three or four different languages. I am referring to management terms. To one group the word "Management" means one thing; to another group an entirely different meaning is conveyed. The Taylor group, the Society of Industrial Engineers' group, the Management Section group of The American Society of Mechanical Engineers, in a substantial way speak in different terms. In many instances a word or phrase has an entirely different meaning to each group. Hence, there is much confusion. It is a wholesome fact that a joint committee formed of representatives from these and other organizations is now working on a standard terminology of management. This committee has been astounded by the enormous task that it has undertaken. It is almost like starting to write a new dictionary. It will take years to complete the task. It is a highly important undertaking and should be pushed to completion as rapidly as possible.

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Basic Principles of Cost Reduction

Better Management and Greater Production per Man the Essentials

By SANFORD E. THOMPSON

Consulting Engineer, The Thompson & Lichtner Company

THE public has been crying for reduced prices; not 10 per cent reduction, not 15 per cent, but 30, 40, and even 50 per cent; and the retail stores that have made the big cuts are getting the business—they are selling goods. Furthermore, the retailer who bases his prices not on what goods cost but on their replacement value, is getting trade. But there is a limit to this procedure, and the question arises—Of what use is it to sell goods at prices below the cost to replace? In order to satisfy the public and continue selling, the cost of production must be reduced, and the shortness of our business depression, the rate at which business returns, and its permanence, will be governed by the manner in which this is accomplished.

During the period 1917 to 1920, direct labor costs were rising far faster than wages. As typical of this we find from the books of a manufacturer that while the cost for direct labor alone on a certain article was $2.85 in 1917, in 1918 it was $3.20, in 1919 $4.42, and in 1920 $6.60, and that during this period in which these direct labor costs had thus increased 140 per cent, wages had risen only 80 per cent. The difference between these two percentages, then, means a lessening of production per man, and similarly, the increase in direct labor costs might be referred to the increase in percentages of profit that market conditions made possible. Surely under such conditions the worker cannot buy, and since the worker is the chief consumer our mills and our factories must lie idle until some of these excess values are eliminated.

Manufacturing Costs Must Be Reduced

But we must not only get back to normal production per man and to normal profits—we must go further. Manufacturing costs must be reduced to even a lower level than before the war[1] and this must be done without reducing wages in like proportion, for at least a part of our higher living standards must be maintained and our progress must continue to be upward and not downward.

But merely lowering wages and lengthening hours of labor will not produce the result, for by lowering wages beyond the point necessary to balance recent inflation both purchasing power and consumption are also lowered. In India wages are low; a skilled laborer works for one rupee, 29 cents per day, or approximately, one-thirtieth of our present rate in America. And why? A relative in India writes me that it took his native painter twenty-four days to put one coat of paint on his Ford car—and this was record time. Low production per man which necessitates such low wages is the cause of India's poverty, and it explains why the Hindoo has not money enough to buy his rice and the strips of cloth that he uses for clothes. It illustrates the fact, moreover, which is generally recognized in theory but not always appreciated in practice, that the only solution for our economic problem is a greatly increased production per man.

Developments Will Come Through Methods

Soon after the close of the Civil War there was a marvelous development in machinery which was chiefly responsible for the continuous increase in wages for a period of some years following. We may secure further developments through machinery but we cannot definitely count upon them. The developments of the immediate future, that will reduce costs, and that will increase production, will be through methods and men, the development of methods in co-ordinating and simplifying the operation of machine and hand processes, and the adoption by both employers and employees of the principle of the fair deal and the golden rule. Both of these are essential, as production development which is not from the heart is futile.

Furthermore, the spirit of love and co-operation can never last as long as conditions in a plant are such that jobs and materials are distributed unevenly, piece rates are set by guesswork—by going into a trance and coming out with the proper rates, as one foreman observed—frequent waits for work occur, quality of work is disregarded, and materials are carelessly wasted.

Only Thorough-going Plans Will Succeed

But satisfactory results cannot be attained through superficial recommendations, nor by short-cut methods. The only plan which will produce real success, is that which studies causes, shows in advance what should be done, analyzes the conditions, adapts special methods to the particular plant, studies processes, and saves

[1] In referring to costs as lower, account must, of course, be taken of any variation in money standard. For example, if the value of money continues low, costs in terms of money may remain permanently at a slightly higher level before the war, even though intrinsic costs are really lower.

materials. It is the classification of facts, the job analysis, the intimate study of conditions, the standardization of methods, and the development of a plan of actual control, that produce the real results in output, and in cost reduction.

It is through such methods as these, through such intensive treatment, that it is possible to eliminate unnecessary operations, determine the best equipment and machinery, standardize methods and quality, and above all, create enthusiasm in the worker. It may be said that these objects are not novel, that every manufacturer is striving his utmost to achieve one or more of them. Agreed, but this is just the trouble; he is attempting merely one, or two, and he fails. There is scarcely a problem in the factory but involves thorough analysis, control of work, and development of the worker, in order to produce effective results.

Ordinary vs. Scientific Methods

The distinction between the methods which must be followed and the ordinary plan is this: The one, the ordinary method, attacks simply the obvious and demands quick results, overlooking the basic principles of scientific development. On the other hand, essentials for the treatment which make for large and permanent increase in production and which make for reductions in costs measured not by thousands but by hundreds of thousands of dollars include an analysis of the work to eliminate unnecessary operations and to standardize methods; the development of a control which actually plans out the work in advance so that the workers get their jobs and materials just as they are needed to use on the jobs; and finally the creation of enthusiasm in order to induce the worker to take a real interest in his work.

To illustrate the difference between the old and the new plan in a plant where there are complex operations and varying materials, the writer recalls a certain operation which was put on piecework by the ordinary but superficial method. Time studies were made and records examined to try to find out how much more the workers could do with an incentive, and rates were set which averaged the variables. The output increased 50 per cent but the results were absolutely unsatisfactory. Quality conditions had not been regarded, the product was too variable to use average rates, the pay of the workers varied, and the plan was thrown out. Then the job was tackled in a really thorough manner with due allowance for variables, with improvements in the machines and equipment and with rates based on accurate analysis. As a result the production was increased over 100 per cent and a satisfactory method was put into permanent operation.

The Vital Principle in Management

The development of control under old or traditional methods of management has been as little appreciated as analysis itself. In fact, even now some manufacturers little realize the absolute necessity for the control feature of the plan and are satisfied with a system that simply follows and keeps track of the work that is being done instead of actually planning it out in advance and arranging for distribution of materials and jobs.

In speaking of such control in a factory, we do not have in mind the authority of the manager and of the foremen over the workmen and the flow of material, but refer to the more recent functional control, the control that relieves the officials of petty details, that assigns the various features of the management to those who are best fitted for handling specific duties, and, as we have just said, actually plans out the work. This is a vital principle in modern management, and as a matter of fact, the very largest saving possible in a manufacturing plant is usually through the balancing up of operations, and departments; the avoiding not only of the small delays of operation but the big delays due to the ups and downs of varying products and irregular flow. This can only be accomplished through planning and control.

More and more along these lines must be the trend of modern manufacturing. Even in other features besides direct production methods—standardization of product, maintenance of quality, elimination of waste—must the same principles be applied. We must have analysis to determine standards, control to maintain them, and, fully as important, development of the worker to obtain his confidence and co-operation.

Recognition of Worker as a Man

In this phase of the plan the personality of the worker must be recognized as one of the features to receive most careful attention. In developing new methods one of the easiest problems is to obtain the co-operation of the worker in testing out the plan. When actually starting work, however, there is apt to be a difficulty in making the right start no matter how honest and conscientious the worker. The worker is used to haphazard methods, and though starting out he may go well, later, not realizing the necessity for following the best method in every case, he is apt to fail. Encouragement, teaching, and fair play are essential in producing the ultimate results.

Moreover, the developments that have been described go a long way in themselves toward satisfying the worker. By planning the work delays which are so exasperating to the worker will be avoided; by routing the work and materials a fair assignment of jobs not one day in the week but every day in the week will be obtained; by analyzing the operations in detail it is easily shown how the work can be done; and finally by prevention of defects in materials penalizing the worker through no fault of his own is avoided. The men, too, may feel that in doing their work well they have the satisfaction of accomplishment. These conditions make for the permanent contentment of the worker, as well as for that increase in production and lowering of costs which must be attained if our economic problem is to be solved.

Labor maintenance in industry. Management 658.4
Safety devices and measures 614.8

The Unexpected Trend in Accident Prevention

Long Service, Good Health, Contentment, Cleanliness, and Carefulness Are More Important than Mechanical Devices

By C. B. AUEL

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IN what may now well be called the dark age of the safety movement, although it is but a few years ago, so rapid has been that movement's growth, safety was generally thought to be something with which only the industries and transportation companies were concerned. It was supposed that the general public had little to do with the matter of safety except perhaps to criticize and to sit in judgment when a particularly distressing accident was described in the columns of the daily press. The public, however, has never had any legitimate right either to usurp the part of critic or to act as judge; for the public itself is the greatest offender, being largely responsible, or guilty, whichever one chooses to call it, not only for accidents in the homes, on the streets, and along the highways, but to a considerable extent as well for accidents and their consequences in the industries.

This country was terribly shocked, and quite properly so, at the losses it sustained in the Great War; for our losses totaled 50,000 killed and 200,000 injured. Yet in our very midst during the same time a much more dreadful slaughter went on and most of us did not even know of it. During the war period of 19 months there were killed in peaceful America 126,000 persons (79,572 per year), while 2,000,000 were so injured as to be totally disabled, some for a month or so, some permanently. Unfortunately this situation cannot be considered an abnormal one, for the United States Census Bureau states that approximately 80,000 persons are accidentally killed in this country every year. Why is it these facts are not known to the general public? Simply because all the accidents do not occur in one place, as does a battle. A few happen in this vicinity, a few in that, and learning of only a small number of them the average individual does not realize the seriousness of the situation.

Causes of Accidents in the United States

Of the 80,000 persons accidentally killed in the United States last year, 58,000 met death on the streets, along the highways, and in the homes; while 22,000 were killed in the industries. A glance at one week's partial death list (see Table 1) prepared last year by the National Safety Council with the aid of 210 county coroners, will be further illuminating as showing the more prominent causes.

These figures point out vividly that accident prevention is an affair of the community, of the nation, not of a class; and as soon as this fact is realized by the public at large, greater progress will be made. Beyond a doubt accident prevention needs the help of every individual if it is to be successful.

The present-day safety movement may be said to have had its inception, or at least to have received its impetus, in the industries. Even in the industries, however, its magnitude and importance were at first overlooked, as accident prevention was felt to be largely a matter of routine having to do in the main with mechanical safeguarding of tools and equipment.

TABLE 1. ONE WEEK'S PARTIAL LIST OF ACCIDENTAL DEATHS IN THE UNITED STATES

Automobiles	245
Falls	153
Railroads	118
Drowned	106
Burns	46
Trolleys	33
Electricity	10
Elevators	10
Miscellaneous	77
Total	798

With the installation of such equipment the objects of the movement, it was supposed, would be effectually obtained. Having no data by which to be guided, each works formulated a program of its own, which it then proceeded to carry out more or less methodically and successfully. But as time went on and as those having charge of this work had opportunity to meet and exchange experiences it was found that the experience of one was that of all, namely: that notwithstanding the safeguarding of tools and equipment, either wholly or in part, accidents still continued. It is now becoming more generally recognized throughout the industries that while this kind of safety work has its place, and an important one, it is by no means the entire solution of the problem.

Labor Turnover in Relation to Accidents

A number of years ago, when safety work was first placed on a methodical basis in the works with which the writer is connected, analyses of various kinds were made of the accidents which had occurred during the several years preceding, with a view not only of preventing any recurrence of the same kind of acci-

dent, but also to forestall if possible every kind of accident. Some exceedingly valuable information was thus obtained; for example, it was found that by far the greatest percentage of accidents happened to the newer employees, that is, to those who had been in the service under one year. It was further found that such accidents were considerably more severe in the matter of consequent disability and of lost time than were those occurring to employees longer in the service.

As our own plants may be considered in nowise exceptional either in the occupations or the hazards of the workers, this information, it was believed, could be translated into a more general statement for the benefit of others as well as ourselves; and as far as the writer is aware, our company was the first to make the announcement that "minimum labor turnover is one of the greatest safety devices which can be installed in any plant." This fact lends emphasis to the desirability of the employment department of every plant putting forth extra effort toward securing in the first place workers who will not be of the rolling-stone variety and using, in the second place, every endeavor to hold them in the service, trying them out in other positions if they do not fit in the position first tried. It is questionable, however, if the thought ever occurs to the average worker that the mere changing about from one plant to another increases his chances of getting injured.

Our accidents were further divided into arbitrary classes, and by occupations, sex, age, nationality, education, experience, wage method, hour of the day, day of the week, month of the year, etc. Attention was then concentrated on the so-called "high spots" with a view to their possible reduction or elimination. In some instances our experience but corroborated that of others, in other instances it did not; nevertheless, in our accident prevention work, we have always endeavored to take advantage of the experience of others wherever it was thought conditions were at all similar, having in mind the old adage that while "experience is the best of teachers, her fees are very high." To illustrate, statisticians have pointed out that accidents happen twice as frequently to non-English-speaking foreigners under an English-speaking boss as to foreigners who understand the English language. Again they tell us accidents happen to young persons as frequently as to new employees.

The experience in any one works may not demonstrate this, or it is possible the facts may not be recognized in an individual plant, but by adding the experiences of a number of plants together the situation is more clearly shown. The employer should therefore take advantage of all such data and employees of the types mentioned above should be placed at work where the hazard of accident is either entirely absent or at least very remote.

Accidents as a Result of Carelessness

Reverting to our division of accidents into arbitrary classes or groups (see Table 2) and our study of each group, the one group that gave us more concern than any other was that of "Carelessness," averaging as it did between 24 and 25 per cent year after year. And not only did we seem unable to arrive at any satisfactory plan for reducing the percentage, but no one else was able to help other than to suggest that vague panacea for all human shortcomings—"education." In talking at different times, however, with our own men as well as with those who had been injured in other plants, it began to appear as if "carelessness," instead of being a cause of accident to the extent it had previously been considered, might in some cases be an effect. If this is the fact, what are the true causes of carelessness? They are doubtless many; but, in connection with accidents, they would seem to be principally ill health and worry. We do not, of course, intend to convey the idea that there is no such thing as carelessness pure and simple, but the further our investigations take us the more inclined we are to feel that, in the past, too many accidents have been attributed to carelessness instead of to the real underlying causes.

TABLE 2. CLASSIFICATION OF ACCIDENTS

Cause of Accident	Aver. 1913 to 1917	1918	1919	1920 9 mo.
Flying objects, cinders, chips, solder, etc.,	16.1	17.6	12.2	16.0
Handling sheet material	2.5	9.0	1.5	3.0
Slipping and falling on stairs, floor, etc	4.9	4.6	6.4	4.3
Injured under ordinary conditions	15.4	21.7	19.8	16.1
Hand tools used by injured	6.4	6.3	4.6	8.2
Elevators and hoisting machinery		0	1.4	1.5
Lifting work into and out of machines	3.3	3.9	5.0	3.1
Electric shock and flash	1.8	1.6	3.3	2.3
Due to fellow workman	4.7	4.0	3.7	5.2
Burns due to causes other than electricity	1.8	2.9	3.8	2.7
Handling, lifting, or moving material other than work into or off machine	12.3	12.4	13.8	13.7
Want of safeguards	0.2	0	0	0
Defective materials	1.3	2.5	1.3	1.2
Carelessness of the injured	24.6	11.9	16.	11.2
Miscellaneous	4.5	9.7	7.2	11.5

Elimination of Causes of Carelessness

Having arrived at this tentative conclusion, our attention was then directed to a study of ill health and worry, with the object of doing something practical towards their reduction, even if it were not possible to replace them wholly by their opposites—good health and contentment. A regular system was instituted of visiting all absentee employees where the absence was in excess of two or three days and the cause not known to the foremen; and included with these absentee employees were those who had met with disabling accidents in our works.

This scheme has been consistently developed during the past several years until now from 500 to 2,000 home visits are made per month. Injuries which necessi-

tate the employees laying off from work but which do not require hospital treatment are closely followed, and many of them are dressed at home by our own surgeons. In cases of sickness no attempt, of course, is made to replace the family physician; but where it is found that the services of a physician are desirable, every effort is made to induce the employee to secure them. Also, where it is felt a nurse would be of assistance, this service is supplied without cost for a day or two, after which, if longer attendance is requested, a regular charge is made.

Investigation of our sickness records showed that what may be called "community ailments," namely, intoxication, tuberculosis, and venereal diseases, were all too common, and measures were instituted to combat them. Later, when prohibition came into effect, our campaign against intoxication was rendered no longer necessary and we were enabled to concentrate our efforts on tuberculosis. So vigorously indeed has this work been prosecuted, that today there is not a tubercular employee in our main plant.

The Campaign Against Tuberculosis

With the splendid facilities afforded by the state of Pennsylvania in its three magnificent sanitariums, where its citizens can be treated free of all expense, and with the equally fine support of the State Department of Health, the task of combatting tuberculosis, otherwise an almost insurmountable one, was rendered comparatively easy. In recognition of our efforts the State has recently designated our works as one of its representatives in this field of endeavor, perhaps the first time such a thing has ever been done. The great majority of our employees who have taken the treatment have recovered and are back at work in one capacity or another; some have gone to their homes or to more congenial climates, and some few have been lost because we did not get hold of them in time or because they refused to take the treatment offered, owing to the advice of friends who assured them that association with others similarly afflicted would aggravate rather than help their condition. Bad advice seems to be the one crop that flourishes equally well through hard and good times alike.

The Fight Against Venereal Diseases

Our campaign against venereal diseases has been under way for some time; but, owing to its being so new from the viewpoint of industry, though world-old in actuality, we have not had such a definite program to follow as in the fight against tuberculosis. All male applicants for employment, however, are examined for venereal diseases, and where infection is discovered they are urged to go at once to the State Clinic or to a physician, with the promise of employment as soon as the risk of infection is over. It seems absurd that these diseases have been almost totally ignored by the states, while other diseases of less malignity, like smallpox (syphilis is sometimes designated as big pox in contrast), have received attention. To show how appreciative are those afflicted with these diseases of any little help or direction toward a possible return to health, one has but to embark on this work.

As a further step, pamphlets treating of these matters are also given to all new employees, both male and female. These pamphlets, which are designated as "Man Power" and "On Guard" for the men and women respectively, were not original with us but were obtained from outside sources, the first from the United States Public Health Service, and the second from the New Jersey State Department of Health. Both pamphlets have been slightly modified to make them suitable for present needs, and they further contain on the inside front cover the legend, "Issued by the Westinghouse Electric and Manufacturing Company, to promote the nation-wide campaign for venereal disease control"; so that the reason for their use cannot possibly be misunderstood. Lectures and first-aid talks have also been given to the more mature among our employees, both men and women. Further steps are in contemplation, and here, too, the Pennsylvania State Department of Health is endeavoring to hew the way.

Beneficial Results of Health Campaigns

Generally speaking, the results of these efforts have been most gratifying. Not only have we been able to be of real assistance to our employees on many occasions, but they have been led to ask our assistance in connection with some of their other problems quite removed from those under discussion. The confidence of the workers in the management thus being steadily fostered will, if circumstances permit a continuance of this work, go a long way towards offsetting much mischievous propaganda of one kind and another, to which every plant is more or less subject. Disregarding entirely, therefore, the humanitarian aspect, the investment is well worth while.

There have also been, quite unexpectedly, other returns as well. The amount of time previously lost by reason of both sickness and accident, for instance, has been reduced, as is shown, month after month, by a steady increase in the money reserve of our sick-benefit association, and by a reduction in the accident severity rate.

It will not do, however, to assume that what has been accomplished has been wholly due to the work outlined, as other agencies have also been involved, and it is difficult, if not quite impossible, to determine relative values. Government reports have said that sickness puts the breadwinner of the family down and out six times as often as do accidents. Any reduction, therefore, in lost time due to sickness is not only an economic gain in itself, but if it be agreed that a distinct connection exists at times between sickness and accident, then a reduction in the amount of sickness means also a reduction in the number of accidents.

Still another gain may be pointed out as the result of a reduction of lost time from any cause. Absenteeism necessitates a replacing of help. If production is to be maintained, more help involves an increase in labor

turnover, while this in turn results in a greater number of accidents; since, as stated previously, in the average plant, it is the new employees who usually suffer the majority of accidents. If from no other standpoint, therefore, than that of self-protection, employers must go into these matters; for on them compensation laws quite generally place the burden, not only of accident prevention but of the consequences of accident, regardless of the fact that while the injury itself may often be merely a trifle like a pin prick, or a bump on the shin, it is unfortunately the culmination of a life of dissipation, carousal, or even sickness inherited or otherwise on the part of the employee.

The Ailments of Industrial Workers

Membership in our sick-benefit association, previously referred to, requires that a simple physical examination be undergone; and, if a defect is encountered, such as poor vision, decayed teeth, enlarged tonsils, etc., the applicant is urged to have it corrected within a given period, in order that he may be accepted as a member. Even where the defect is permanent, limited membership may still be obtained by the applicant, providing a release is signed to the effect that if sickness disability ensues from the defect specified, benefits will not then be paid, but that in all other cases they will be. Tables 3 to 6 give an exceedingly good idea of the ailments which handicap, in a greater or lesser degree, the working classes in industry. These tables have been compiled from examinations made covering a period of something over three years and are believed to be thoroughly representative both in kind and in degree. They may therefore indicate where the problem of accident-prevention from the health standpoint should be attacked.

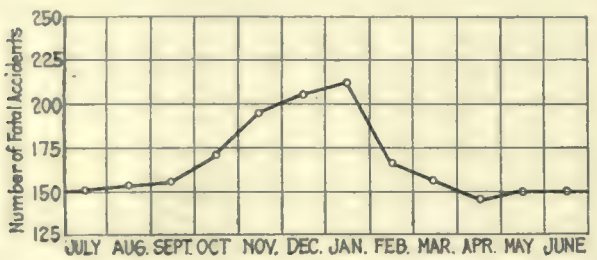

FIG. 1 LIGHTING AS A FACTOR IN REDUCING ACCIDENTS

Relation between the number of fatal accidents in industry and the months of the year plotted from information on 95,000 accidents. Note how the number of accidents increased during the winter months coincident with the short dark days, and fell off in summer with the corresponding long light days.

Good Lighting as a Preventer of Accidents

From what has thus far been said it is quite clear that if the most progress is to be made in accident-prevention work, there must be an interchange of experiences and ideas and the widest publicity given to all worth-while happenings. Accordingly there is shown in Fig. 1 a chart compiled by the Travelers Insurance Company from data gathered by John Calder on 95,000 accidents. This chart demonstrates very conclusively the part good lighting can play in accident-prevention, as it shows how accidents increase during the winter months coincident with the short dark days, and fall off in the summer months with the corresponding long light days.

Similarly, a comparison of accidents in the iron and steel industries from 1905 to 1910 showed that at night the accidents in the mechanical department were 118.3 per cent greater than in the day, while in the yards

TABLE 3. TOTAL NUMBER OF PHYSICAL EXAMINATIONS (MEN) FOR THE YEARS 1918, 1919, AND 1920.

CLASS OF DEFECT	1918	1919	1920
Class 1. No defects.	4,282	7,383	2,586
Class 2. Defects such as enlarged tonsils, faulty vision, defective teeth, hernia, etc., which can usually be corrected by simple methods.	12,474	20,572	14,133
Class 3. Serious constitutional defects, the cure of which is problematical, making the applicants ineligible to membership in our sick-benefit association.	1,634	1,851	1,139
Total	18,390	29,806	17,858

TABLE 4. CLASS 2 AND 3 DEFECTS (MEN) AS SHOWN BY PHYSICAL EXAMINATIONS FOR THE YEARS 1918, 1919, AND 1920.

CHARACTER OF DEFECT	CLASS 2			CLASS 3		
	1918	1919	1920	1918	1919	1920
Vision	588	2,722	2,572	480	587	107
Hernia	4,058	6,451	4,565	349	422	172
Fingers	28	172	55	6	6	4
Hands, Feet (including ankylosis and amputations)	94	124	66	7	7	9
Extensive scars	24	132	323	9	12	2
Varicose veins	42	69	25	47	57	2
Varicocele	197	743	692	21	27	2
Hydrocele	12	36	31	5	6	2
Hemorrhoids	7	7	1	7	7	.....
Venereal diseases	1	2	35	117	183	212
Deformities, including spine	10	28	23	8	10	5
Teeth	946	2,224	1,294	.....	4	9
Hearing	5	.....	11	3	3	1
Tonsils	243	366	374	4	4	1
Heart	40	418	441	98	148	123
Lungs	5	156	547	17	44	90
Underweight	1	7	557	1	1	.....
Overweight	.....	.....	31	.....	.....	.....
Skin diseases	11	26	69	5	15	18
Nasal obstructions	1	1	.....	.....	.....	1
Mental condition	3	4	.....	.....	2	.....
Nervous diseases	1	2	.....	163	165	1
Goiter	12	13	1	6	6	.....
Two or more Class 2 defects only	6,134	6,801	2,420	8	8	4
Two or more Class 3 defects or general disability	.....	.....	.....	119	119	204
Miscellaneous	11	68	.....	154	8	170
Totals	12,474	20,572	14,133	1,634	1,851	1,139

they were 127.6 per cent greater. The United States Government report on the subject states that "the night force of yardsmen is smaller than the day force, but their duties do not differ sufficiently to afford an adequate reason for their higher rate. The influence which it would appear could exert any considerable effect upon their rate is the difference in lighting."

What is it, then, that good lighting accomplishes in the prevention of accidents? Nothing, of itself, but by pointing out the unsafe places, the obstructions, the tripping and falling hazards, the filth, and the dirt, it tends toward their removal; moreover, it introduces a bit of cheerfulness, the antidote to so many of the lesser ills, into even the gloomiest surroundings. It may therefore be set down as one of the principal safety devices which can be installed in a plant. As for cost, it can be shown in a rather interesting way[1] that good lighting pays for itself provided it be admitted that a worker in a poorly-lighted shop could, if given good lighting, increase his output by about 1½ min. worth of work in the course of a normal working day. How many factory managers, however, haggle over suitable light for a machine tool, for which they have perhaps paid several thousand dollars, unwittingly risking accident as well as output because they can neither figure nor profit by the experience of others.

TABLE 5. TOTAL NUMBER OF PHYSICAL EXAMINATIONS (WOMEN) FOR THE YEARS 1918, 1919 AND 1920.

CLASS OF DEFECT	1918	1919	1920
Class 1. No defects.	1,243	2,486	1,699
Class 2. Defects such as enlarged tonsils, faulty vision, defective teeth, hernia, etc., which can usually be corrected by simple methods.	1,699	2,549	1,134
Class 3. Serious constitutional defects, the cure of which is problematical, making the applicants ineligible to membership in our sick-benefit association.	326	548	111
Total	3,268	5,583	2,944

TABLE 6. CLASS 2 AND 3 DEFECTS (WOMEN) AS SHOWN BY PHYSICAL EXAMINATIONS FOR THE YEARS 1918, 1919, AND 1920.

CHARACTER OF DEFECT	CLASS 2			CLASS 3		
	1918	1919	1920	1918	1919	1920
Vision	167	280	109	212	317	63
Hernia	.....	.....	1	.....	.....	.....
Fingers	.....	.....	.....	.....	.....	.....
Hands, Feet — Including ankylosis and amputations	13	13	.....	.....	.....	.....
Extensive scars	4	5	1	.....	.....	.....
Varicose veins	16	16	10	1	4	1
Varicocele	.....	.....	.....	.....	.....	.....
Hydrocele	.....	.....	.....	.....	.....	.....
Hemorrhoids	.....	.....	.....	.....	.....	.....
Venereal diseases	.....	.....	.....	.....	.....	.....
Deformities, including spine	.....	.....	3	.....	.....	.....
Teeth	921	1,275	373	6	43	.....
Hearing	1	1	3	.....	.....	.....
Tonsils	75	141	306	1	11	.....
Heart	22	29	17	6	6	8
Lungs	6	15	7	2	4	1
Underweight	.....	.....	.....	.....	.....	.....
Overweight	.....	.....	.....	.....	.....	.....
Skin diseases	3	9	10	4	6	1
Nasal obstructions	1	2	6	1	1	.....
Mental condition	.....	.....	.....	.....	.....	.....
Nervous diseases	2	5	1	.....	.....	.....
Goiter	4	6	5	.....	.....	2
Two or more Class 2 defects only	460	732	281	7	.....	.....
Two or more Class 3 defects or general disability	.....	.....	.....	.....	124	11
Miscellaneous	4	20	1	86	32	24
Totals	1,699	2,549	1,134	326	548	111

BENEFITS OF CLEANLINESS AND NEATNESS

Cleanliness and neatness are closely related and can hardly be omitted from consideration among the big items in accident-prevention work. It has just been stated that good lighting in a plant showed up the obstructions, the tripping and falling hazards, the filth, and the dirt, and in so doing tended to their removal; but in order to accomplish the removal of such accident-producers or breeders, something more is required, namely, a desire for cleanliness and neatness. Since health has also been shown to be a large factor in accident-prevention work, it follows again that in order to secure health in full measure, cleanliness and its ally, neatness, must be further taken into account. And lest it be assumed wrongly that plant cleanliness and neatness are alone referred to, the point is distinctly emphasized that personal cleanliness and neatness are included as well. The assertion is here made that while too little attention has been paid up to the present time to the sanitary condition of plants, even less attention has been given to those who make the conditions unsanitary.

Attempting to teach factory-working adults the fundamental rules of health, including cleanliness and neatness, is no doubt beginning at the wrong end; nevertheless, the effort should be instituted where it has not yet been tried, and continued where it has been tried, even though the investment yield be not altogether encouraging. At the same time similar work must be more fully developed in the schools, as being the most promising field of all.

ILLITERACY IN RELATION TO ACCIDENTS

This country has always taken pride in its high degree of literacy, but the war effectually dissipated that feeling when it showed that 25 per cent of our soldiers could neither write nor read intelligently. It has been stated by Dr. Winthrop Talbot in the *Scientific American*, that about 10 per cent of adults in this country cannot read a word in any language, while about 25,000,000 can barely write their names in English. He further states, "70 per cent of industrial accidents occur to persons who require an interpreter in presenting their claims. In most cases those who

[1] See Appendix at end of article, p. 41.

are injured are unable to read even a danger-sign. A quarter-of-a-million dollars a day is a moderate estimate of the cost of the illiterate to industry in the United States for accidents only, due in large measure to inability to read a danger-sign or to understand ordinary safety instructions, and because of lack of a common language." It may therefore be said that the elements of education, including the ability to read and write English, and the fundamentals of good citizenship, should be numbered among the most important safety devices which can be installed in any plant. Since carelessness has already been set down by most investigators as one of the largest, if not the largest, cause of accidents, its opposite, carefulness, must without further argument be one of the large accident-reducers, especially if it be linked with those qualities, intelligence and skill, with which it is almost always related.

There has been much talk at various times, more particularly by well-meaning but ill-informed persons, as well as by certain individuals among the labor element, to the effect that systems of wage payment involving an incentive require the employee to work at high speed and are thus more or less responsible for accident. Many, if not all, state accident-reports require an answer to the query regarding the wage system under which the employee worked at the time of an accident, but it has yet to be shown that any relationship exists between bonus systems and accidents.

FATIGUE AS A CAUSE OF ACCIDENTS

Fear has also been expressed, principally by social workers, that fatigue is responsible for accidents, brought about, so it is claimed, both by the pace of the workers and the monotony of their tasks. In order to forestall fatigue, it has been suggested that a work day should in no case be over 8 hr. long, and further, that a break should be made in the morning hours, say, by means of a rest period of possibly 15 min. There is doubtless some truth in statements that have been made regarding the effects of fatigue, but candor compels the writer to remark that, with the possible exception of an isolated case here and there, fatigue of the workers is apt to be more the result of their own actions during the two-thirds of the day when they are not under the control of the employer and are their own bosses, than during the one-third when they are actually at work. The chart of Fig. 2 shows that for a three-year period in our works there was practically no difference in the number of accidents occurring on the different days of the week, until Saturday, which, although shorter than any other day, consisting as it does of a morning stretch only (7 A. M. to 11:15 A. M.) as compared with a full day (7 A. M. to 11:30 A. M. and 12:45 P. M. to 4:30 P. M.) is, figured on the basis of a full day, appreciably the worst day of the week.

The only explanation thus far available of the poor showing made on Saturday is that the employees do not have their minds on their work on that day to the same extent as on other days—in other words, that there is more care exercised on the other days of the week. Someone may perhaps advance the argument that these data show the employees to be fatigued on that day as the result of their efforts on the other days; but if this were the case, the accidents should at least increase progressively from day to day, and Monday should therefore be the day of fewest accidents.

If now a resumé be made of the several matters discussed it will be seen that in the writer's opinion—an

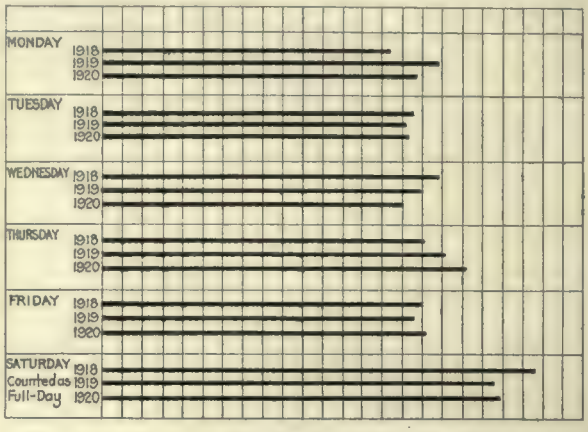

FIG. 2 FATIGUE AS A CAUSE OF ACCIDENTS

The chart shows that in one plant for over a period of three years there was practically no difference in the number of accidents occurring on the different days of the week until Saturday was reached, which although shorter than any other work day shows the greatest number of accidents.

opinion in which he believes many other observers will agree—the most important safety devices which can be installed in the average industrial plant are:

1. Minimum labor turnover
2. Good health
3. Contentment
4. Cleanliness and neatness (personal and plant)
5. Good lighting
6. Prohibition
7. Education (English language at least)
8. Mechanical and equivalent guards
9. Carefulness.

In this list the writer does not wish to imply that the items have been set down in the order of their importance, for, even if it were agreed by everybody that the individual items were correct, the order of their importance would no doubt vary in different plants and industries. In any event it is seemingly clear what the trend is in this work of accident prevention. Safety is not simply a shield which the employer can and should throw around employees during working hours, nor is it merely a temporary protection needed by employees for working hours alone. On the contrary, it is a safeguard needed by the entire nation during every hour of the day. Unfortunately, accident prevention is not something which can be made or performed by the few for the many; but it is a thing which everyone, young and old, big and little must assist in bringing about, and until everyone does his full part, the consequence of our national negligence will be felt.

APPENDIX

Assume any average factory space in which five men can work comfortably, the general lighting being furnished by one 500-watt overhead lamp, in addition to which there are five 60-watt lamps, one for each worker whether on a machine or not.

COST OF INSTALLATION

Wiring

Material	$16.00
Labor	14.00
Overhead (30 per cent)	4.20
	$34.20

Lamps

One 500-watt	$3.68
Five 60-watt	1.80
	$5.48

Reflectors

One 500-watt	$3.00
Five 60-watt	2.50
	$5.50

COST OF OPERATION

Washing

Labor	$2.05
Overhead (30 per cent)	0.615
	$2.67

Current

One 500-watt = 500 watts
Five 60-watt = 300 watts

800 watts = 0.8 kw.

Assume 3 cents per kw-hr. as cost of current, and that the lamps burn 26 hr. per week throughout the year ($26 \times 52 = 1352$ hr.), then yearly cost for current $= 0.8 \times 0.03 \times 1352 = \$32.448$.

COST OF MAINTENANCE

(Includes 10 per cent and 20 per cent depreciation and 6 per cent interest)

Wiring. $34.20\ (0.10 + 0.06) = 5.472$.

Reflectors. $5.50\ (0.20 + 0.06) = 1.43$.

Lamps. $2[5.48 + (5.48 \times 0.06 \times 6/12)] = 11.28$. (Assume all lamps to be replaced in 6 months.)

TOTAL COST OF MAINTENANCE AND OPERATION

Wiring	$ 5.47
Lamps	11.28
Reflectors	1.43
Washing	2.67
Current	32.45
	$53.30

HOURS OF EMPLOYMENT AND COST OF LABOR

Assume: 8 hr. per day; 6 days per week; 48 hr. per week; 52 weeks per year; and 5 employees in lighted area.

$48 \times 52 \times 5 = 12{,}480 =$ total hours worked by 5 employees per year.

$53.30 \div 12{,}480 = \$0.0042$ cost of good lighting per hour.

$0.0042 \times 8 = \$0.0336$ cost of good lighting per man per day of 8 hr.

Assume also that poor lighting will cost at least one half as much as good lighting: $\$0.0336 \div 2 = \$0.0168$ increased cost of good lighting over poor lighting per man per day of 8 hr.

LABOR COST, ETC.

Direct Labor = 70 cents per hr.

Factory Cost (assume as: 5 x Direct Labor) = $3.50.

Commercial Cost (125 per cent Factory Cost) = $4.37.

Selling Price (115 per cent Commercial Cost) = $5.05.

Profit = $5.05 — $4.37 = 0.68 cents per man per hr., or $5.44 per day.

If the profit on output therefore, labor alone being considered, is $5.44 per man per day, then 1/544 would represent the part of a day required to earn 1 cent profit, and $1/544 \times 1.68$ cents would be the part of a day required to earn 1.68 cents profit, or the part of a day required to earn the increased cost of good lighting over poor lighting per man; that is,

$1.68 \div 544 = 0.003$ day
$0.003 \times 8 = 0.024$ hr.
$0.024 \times 60 = 1.44$ min., which was to be proved.

Management engineering. Education *658(07)*

Education for Proprietorship

By ARTHUR E. MORGAN

President, Dayton Morgan Engineering Company

ANTIOCH COLLEGE, Yellow Springs, Ohio, has undertaken a new program, a major element of which is the training for proprietorship and for active management and administration in industry and business. The calling of proprietorship is a much larger one than it might seem to be at first thought. The number of Americans who own and administer their own business runs into the millions. The farmer, for instance, is essentially a proprietor and an administrator, for he must personally exercise the various functions which relate to administration. He is his own accountant, cost keeper, personnel manager, salesman, buyer, and production engineer. The same in general is true of operating owners on a small scale of mines, quarries, mills, factories, machine shops, and of retail stores, as well as of professional men in private practice, such as doctors, lawyers, and engineers.

The managing proprietor is a member of a distinct and definite profession, although this fact has not generally been recognized. To be thoroughly successful such a man or woman must have a general knowledge of all elements of his calling, sufficiently definite to enable him to act intelligently in any phase of his business when it is on a small scale; and to know when he needs expert assistance, and whether he is being properly served when his business is on such a scale that he should call in outside help. In addition to these qualifications universally necessary in management, the managing proprietor needs to possess certain other qualifications which are not so essential in the case of subordinate administrators in a large corporation. The managing proprietor must be the seat of final judgment. There is no appeal from his decision. If his final judgment is in error the entire business suffers. If he lacks self-reliance, the business hesitates to take advantage of its opportunities. If he does not possess initiative, it stays in a rut.

SUCCESSFUL MANAGEMENT DEPENDS UPON SKILL

It has been assumed generally that the successful managing proprietor is born and not made; that no amount of schooling will take the place of native ability; and that as a preparation for this type of management the school or college has practically no value. When we come to analyze this type of management, however, we find that its successful exercise depends to a considerable extent upon the possession of certain specific types of skill and knowledge; and that no matter how much native ability men or women may possess, unless they in some way acquire such

skill, the full value of native ability will not be realized. Success for the Antioch program depends upon securing a very carefully selected student body of persons who probably have capacity for development of the qualities of the manager and administrator; and then in giving such persons an education in the elements of their calling through combined study and practice. This calls for a co-ordination of technical and cultural education, to be accomplished by uniting the fundamentals of a cultural education with the essentials of a professional or a technical education, for, at the time when the student is being fitted for his work, a profession or a vocation, he is also being prepared for effective citizenship.

It is this kind of preparation for administration, management, and citizenship that Antioch College has undertaken to furnish. As a primary requisite to success, the student body must be chosen with unusual care, since only a minor fraction of those who come to college would ever develop to any marked degree the qualifications of the administrator. From the very large number of applications for admission to Antioch, selection is being made of a limited number who give greatest promise of having the necessary qualities.

Factories on the College Campus

All of the students at Antioch, except a few who may wish cultural courses only, will spend half their time at college and half their time in financially productive work. This program is arranged in alternative five weeks' periods, so that a student is able to give all of his energy to the particular job in hand; that is, first college work for five weeks, and then creative work for five weeks. A number of the students will be engaged in the various industries in the nearby cities. The plans for the college provide, however, for the erection on the campus of an industrial building in which will be located a number of small industries chosen because of their educational value, and because of the productive capacity they give to the students' working time.

The industries to be acceptable for location in the campus factory building must demand workers of high intelligence. This will prevent students from competing with unskilled and unintelligent labor; will increase the educational value of the work done; turn out a product for which there should be a reasonably uniform demand; and should increase the earnings of the students. As a rule, students who work their way through college do so by engaging in unskilled labor. By organizing their work in a high-grade industry, the students' earning capacity should be materially increased and the strain of self-support considerably relieved. It is hoped that, ultimately, conditions will be such that students can very largely support themselves during their course by their work in industry.

These industries, however, will all be small industries, and as such they cannot individually afford the high-grade administrative service, such as accounting, cost keeping, personnel management, etc., which is necessary for the highest success of an industry. Accordingly, it is planned to have a centralized administration service for the entire group of industries. There will be a single administration office in which such parts of the work as accounting, personnel organization, industrial health organization, and other phases of administration as can feasibly be centralized, will be gathered. Even the administrative service to all of these industries will not sustain the administrative type of organization that is desired for the purposes of the college. It is therefore planned to furnish industrial service to some of the nearby industries.

The Antioch service will include accounting, cost keeping, public health, personnel administration, publicity, traffic, and possibly a purchasing service. Other types of service will be added as the field opens. In so far as it is feasible the assistants in this administrative service will be undergraduates, and the service will form a laboratory in business administration. The primary essential is that the service which is offered shall be of such unqualified character as to result in a favorable reputation of Antioch service as such, regardless of the field in which it is offered.

With the aim of preparing for administration and management, there will be a single common course in administration extending through the earlier years, diversified in the later years by training in administration in particular fields. A few specific lines of training in special fields are to be undertaken. These include educational administration, civil engineering, printing, publishing, machine-shop operation, farming, institutional management, and household management. The two latter courses are aimed to interest women in particular, although women will be admitted to any of the other courses.

Education to Aid Industry

American industry is to-day keenly aware of the need for foremen, minor executives, and superintendents of approved managerial capacity. Numerous educational institutions are endeavoring to train such men; but few offer preparation for the ultimate responsibility of management by a combination of study and practice resting upon a foundation of general education and culture. Antioch purposes to carry this combined education further than any other institution in the United States, realizing that the technique of responsible control and management is becoming highly developed, but that this body of knowledge and practice is not the general possession of American business or industry. Seemingly, making the knowledge of the best practice in management generally available to the people who need it would be a fundamental service almost comparable to the widespread extension during the last century of the knowledge of reading and writing.

In thousands of American industrial organizations success is awaiting the appearance of the trained manager. His equipment of knowledge and skill must assist him to synthesize our economic life without cultural and moral standards. Antioch purposes to assist its students to achieve, experimentally during their college years, a correlation of business methods, industrial practice, and cultural aims.

Existing Courses in Management Engineering

By COLLINS P. BLISS

Head of the Department of Mechanical Engineering, New York University

Analysis of the positions held by the graduates of engineering colleges shows that only fifteen to eighteen per cent stay in technical work. The major portion enter widely different pursuits, although many seek positions of executive or managerial responsibility. This situation, and the need of industry for trained intelligence to direct and operate its complex activities, has caused a number of the engineering schools to establish new courses to educate executives. The Society of Industrial Engineers has also planned such a course. At the convention of that society held in Pittsburgh in October, 1920, Professor Bliss presented a brief address comparing some of these courses. He has now expanded that address into a comprehensive paper showing the make-up of eight courses and giving the time allotted to each general group of subjects and to each study.

CALVIN COOLIDGE, when Governor of Massachusetts, once said: "Our prosperity comes from our industry and our industry cannot flourish unless it is directed with the highest intelligence. Far more in the future than in the past will this intelligence call for sound training in science and in its innumerable applications to industry." And yet, despite this need, many large manufacturers admit their inability to secure properly trained men to carry out the details of executive planning and of production.

Those studies which most of our technical schools are able to cover in four years are purely the essential fundamentals of the usual courses in civil, mechanical, electrical, and chemical engineering. In fact the basic engineering training today in all types of technical courses is either civil or mechanical. In the early days of engineering, however, the first courses instituted were designated as "civilian" engineering in contradistinction to "military" engineering. But now the cry is heard on every side for that type of training which will furnish men skilled in the art of using that which the civil or mechanical engineer has built, and in a manner to produce the greatest results at the least cost. For the lack of a better name we are calling this training "Management Engineering," and to meet the industrial awakening not far distant in this country and but a little further remote all over the world, it is within the province of the educators of this country to rise to the emergency and prepare for the market that which the market demands.

The Demand for Trained Men

There is probably at the present time no technical school that has not revised its curriculum in the last few years, and this has come about as a result of the lessons learned from the intensive training called for by the government during the war.

The invasion of an army of men from the industrial walks of life, the everlasting production of those four years of supremacy of essential industries and above all the indisputable fact that "trained" men were the only ones wanted have all worked together to show the schools and colleges of engineering that by the use of trained men more can be accomplished in less time. Moreover, greater co-operation with those that produce is at least one of the signs of the times likely to be displayed for the next decade.

The Industrial Engineer

"Industrial Engineering" seems to be the title most generally adopted to designate those courses which endeavor to train men for constructing, operating, and managing that which the professional engineer has designed. Other designations such as: Administrative Engineering, Business and Engineering, Engineering Administration, and Executive Engineering, all seem to point towards the substitution of subjects that might be generally termed "economic" for the more highly specialized technical ones. The kind of graduate such courses are planned to produce is one who shall possess the qualifications of an executive trained for engineering rather than for business. In other words, in terms of a definition promulgated by the Educational Committee of The Society of Industrial Engineers, "the training of the industrial engineer should fit him to direct and control as an executive all of the agencies and forces of productivity." For the purpose of this paper and its place of publication the term "Management Engineering" has been adopted.

In a paper by Prof. W. H. Timbie of the Massachusetts Institute of Technology, read before a recent meeting of The Society for the Promotion of Engineering Education, we find the following:

> It is these men who in the last analysis must direct the operation of the nation's industries. For our industries cannot compete with those of other countries unless they are conducted by men who have large vision, intimate knowledge of manufacturing details, and a thorough training in science and scientific methods. Manufacturing must be conducted on a sound financial basis, which means that processes of production must be so managed that the total cost of the finished article will be low enough to compete with the products of foreign factories. For this task the service of an engineer who has a thorough knowledge of manufacturing processes are invaluable and his duties multifarious. He must not only be familiar with the best methods of production, but he must thoroughly understand scientific research, in order that he may take advantage of new discoveries and continually better his methods of production.

A feature introduced by nearly all of the institutions offering these new courses is a plan of co-operative work involving direct contact with industrial plants, and even those which have not adopted a definite co-operative plan require their students to spend four or eight weeks during each summer acquiring experience in those lines which either cannot be taught in college, through lack of time and facilities, or which are peculiar to manufacturing and industrial enterprises.

While most of the co-operative courses in this country, from the inaugural one at the University of Cincinnati to the most recent ones at Massachusettes Institute of Technology, the Harvard Engineering School, and New York University, are not confined to courses in Industrial Engineering alone, they show a tendency of the time in making a part of their requirements some form of practical instruction to be obtained only in direct contact with industry itself. But whether the two weeks' period of alternate work at the college and at the industry as introduced by Dean Schneider, or the three months' interval of work in each between the end of sophomore year and beginning of senior year, as tested for ten years at the University of Pennsylvania, is the best for final adoption by all may still be open to argument.

Co-operative Work a Feature of the Course

Still another plan is in operation between the Massachusetts Institute of Technology and the Lynn Works of the General Electric Company, where thirteen weeks are spent in the industry and eleven weeks at the institute alternately for the last three years of a five-year course in electrical engineering.

New York University has a plan confined solely to its course in Industrial Engineering where at the end of the sophomore year the student spends half his time for the remaining twenty-four months of his course at the industry and half at the university in alternate periods of four months each, the longest term yet attempted under the co-operative plan. A fifth year is spent in elementary research or in the investigation of industrial problems either at the university or at the industry or partly at both. The usual B. S. degree is given at the completion of the four-year term and the degree of I. E. at the end of the fifth year under the above arrangement.

Under each of these methods of introducing the student to the great field outside of the college walls, whether this contact be worth more by reason of a short interval or a long one, the fact remains that his education is broadened and his ability to think and act for himself increased.

Typical Courses in Management Engineering

As to the content of those courses now being given under the general title of Industrial Engineering by a half-dozen or more of our leading universities, while the general aim is the same it is variously emphasized. From an analysis of the actual class hours devoted to each subject there seems to be a trend in three directions:

1. Studies looking towards training of a broad executive character.
2. Those taking up the details and methods of production.
3. Courses along business and commercial lines.

What weight has been given to each of these three aspects of the economic substitutions can only be arrived at by a tabulation of the time allotted to courses classed under these heads. This has been done and the results are given in the following schedules in the preparation of which an effort was made to so group the various courses given at the seven technical schools selected that the dominating subjects may be apparent in each curriculum.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Engineering Administration

General Subjects

Mathematics
- Analytical Geometry
- Calculus
- Differential Equations

Language
- English and History
- Written and Oral Reports
- Engineering Addresses

Science
- Chemistry
- Physics
- Military Science

General Engineering Subjects

Mechanical Engineering
- Drawing and Descriptive Geometry
- Machine Tool Work
- Mechanism (Kinematics)
- Machine Design
- Engineering Laboratory
- Heat Engineering Electives

Civil Engineering
- Analytical and Applied Mechanics
- Materials of Engineering
- Hydraulics

Electrical Engineering
- Elements of Electrical Engineering
- Central Stations
- Electrical Laboratory

Specific Subjects

Human Relations
- Industrial Relations
- Labor Problems and Sociology
- History of Industry

Production
- Accounting
- Industrial Organization
- Statistics
- Business Management
- Cost Analysis

Marketing
- Sales, Advertising and Trade under "Business Management"

Finance and Law
- Political Economy
- Business Law
- Banking
- Securities and Investments

PENNSYLVANIA STATE COLLEGE

Industrial Engineering

GENERAL SUBJECTS

Mathematics
- Trigonometry
- Analytical Geometry
- Calculus

Language
- English Composition
- Argumentation
- Public Speaking
- Modern Language

Science
- Physics
- Chemistry
- Military Science

Modern Economic History

GENERAL ENGINEERING SUBJECTS

Mechanical Engineering
- Shopwork (Forge, Foundry, Machine, Woodworking)
- Kinematics of Machinery
- Drawing and Descriptive Geometry
- Heat Engineering and Power Plants
- Machine Design
- Mechanical Laboratory

Civil Engineering
- Elementary and Applied Mechanics
- Engineering Materials
- Mill Building Design
- Metallurgy of Iron and Steel

Electrical Engineering
- Dynamo Machinery
- Industrial Electrical Applications
- Electrical Engineering Laboratory

SPECIFIC SUBJECTS

Human Relations
- Principles of Industrial Engineering
- Psychology
- Social Service
- Political Parties

Production
- Accountancy and Industrial Accounts
- Scientific and Shop Management
- Factory Planning and Inspection Trips
- Industrial Management and Organization
- Time and Motion Studies

Marketing
- Briefly treated under "Industrial Management"

Finance and Law
- Engineering Law and Contracts
- Principles of Economics
- Money and Banking or Commerce Subjects

YALE UNIVERSITY—SHEFFIELD SCIENTIFIC SCHOOL

Administrative Engineering

GENERAL SUBJECTS

Mathematics
- Algebra
- Trigonometry
- Analytical Geometry
- Calculus

Language
- English Literature
- Report Writing and Composition
- Public Speaking
- Modern Language[1]

Science
- Physics
- Chemistry

History and Government

GENERAL ENGINEERING SUBJECTS

Mechanical Engineering
- Engineering Practice
- Drawing and Descriptive Geometry
- Water and Heat Power Engineering
- Mechanical Laboratory

Civil Engineering
- Mechanics and Structural Design
- Strength of Materials and Metallurgy
- General Contracting[2]

Electrical Engineering
- Fundamentals of Electricity
- Generation
- Transmission
- Industrial Applications[2]

SPECIFIC SUBJECTS

Human Relations
- Psychology or History of Industry[1]
- Labor Management
- Social Science
- Administrative Engineering Problems[1]

Production
- Engineering Economics
- Industrial Management
- Cost Accounting
- Shop Equipment and Management[2]
- Machinery and Processes

Marketing
- Sales and Advertising Statistics
- Transportation[2]

Finance and Law
- Business Administration
- Business Finance
- Business Law
- Specifications and Contracts

[1] Junior Electives.
[2] Senior Electives.

COLUMBIA UNIVERSITY

Industrial Engineering

GENERAL SUBJECTS

Mathematics[3]

Language

Science
- Physical Laboratory
- Engineering and Industrial Chemistry

GENERAL ENGINEERING SUBJECTS

Mechanical Engineering
- Power Generation
- Machine Elements
- Engineering Thermodynamics
- Mechanical Laboratory
- Machine Design and Analysis

Civil Engineering
- Metallography
- Mechanics
- Strength of Materials

Electrical Engineering
- Direct and Alternating Current
- Electrical Laboratory

SPECIFIC SUBJECTS

Human Relations
- Public Assets of Business
- Labor Problems

Production
- Principles of Accounting
- Factory Cost Analysis
- Business Statistics
- Factory Management and Equipment
- Manufacturing Processes
- Analysis of Productivity
- Selected Industries

[3] All general subjects covered in 3-year college course.

Marketing
No separate course given
Finance and Law
Principles of Money and Banking
Business Law
Corporation Finance

NEW YORK UNIVERSITY
Industrial Engineering

GENERAL SUBJECTS
Mathematics
Algebra
Trigonometry
Analytical Geometry
Calculus
Language
Rhetoric and Composition
Technical Writing
Survey of Scientific Literature
Public Speaking
Modern Language or American Government
Science
Physics
Chemistry
Military Science and Hygiene

GENERAL ENGINEERING SUBJECTS
Mechanical Engineering
General Engineering Practice
Drawing and Descriptive Geometry
Applied Kinematics
Heat Power Engineering
Mechanical Laboratory
Civil Engineering
Analytical and Applied Mechanics
Properties of Materials
Hydaulics and Hydraulic Motors
Electrical Engineering
Direct Current
Alternating Current
Industrial Applications of Electricity

INDUSTRIAL SUBJECTS
Human Relations
Psychology or Modern Language
Industrial Relations and Employment
Economic or Administrative Problems (Thesis)
Production
Bookkeeping and Accounting
General and Cost Accounting
Factory Organization
Industrial Engineering
Shopwork and Methods
Marketing
Advertising and Selling
Trade and Transportation
Economic Geography
Finance and Law
Business Organization
Principles of Economics
Engineering and Commercial Law

UNIVERSITY OF PITTSBURGH
Industrial Engineering

GENERAL SUBJECTS
Mathematics
Algebra
Trigonometry
Analytical Geometry
Calculus
Language
English
Report Writing
Science
Physics
Chemistry

GENERAL ENGINEERING SUBJECTS
Mechanical Engineering
Shopwork (Forge, Foundry, Machine)
Machine Design
Heat Power Engineering
Civil Engineering
Surveying
Mechanics
Mechanics of Material
Hydraulics
Electrical Engineering
Direct Current
Alternating Current

SPECIFIC SUBJECTS
Human Relations
Psychology
Industrial Employment
Personnel Administration
Production
Industrial Statistics
Cost Accounting
Shop Methods
Time and Motion Studies
Marketing
Advertising (To be treated under Sales Management)
Sales Engineering
Sales Management
Transportation and Foreign Trade
Finance and Law
Credit and Banking
Corporation Finance
Business Law
Contracts and Specifications

PURDUE UNIVERSITY
Industrial Engineering

GENERAL SUBJECTS
Mathematics
Algebra
Trigonometry
Analytical Geometry
Calculus
Language
English or Modern Language
Science
General Chemistry
General Physics
Military Science
Personal Efficiency (Hygiene)

GENERAL ENGINEERING SUBJECTS
Mechanical Engineering
Mechanical and Machine Drawing
Shopwork (Woodworking, Forge, Foundry, Machine)
Kinematics and Machine Design
Engines and Boilers
Power Plants and Transmission
Heating and Ventilating
Mechanical Laboratory and Seminar
Civil Engineering
Analytical Mechanics
Electrical Engineering
Elements of Electrical Engineering
Industrial Lighting

SPECIFIC SUBJECTS
Human Relations
Measuring Mental Ability and Achievement
Psychology (General and Educational)
Safety Engineering and First Aid
Labor Problems and Sociology
Human Nature and Industry
Fundamental Laws and Principles of Human Relations

Production
- Employment Management
- Time and Motion Studies
- Shop Course in Manufacturing
- Industrial Equipment
- Factory Layout and Management Systems
- Cost Accounting
- Industrial Engineering

Marketing
- Salesmanship

Finance and Law
- Elementary Economics
- Business Statistics

COURSE PROPOSED BY THE SOCIETY OF INDUSTRIAL ENGINEERS

Industrial Engineering

GENERAL SUBJECTS

Mathematics
- Algebra
- Trigonometry
- Analytical and Descriptive Geometry
- Calculus (Optional)

Language
- English
- Composition and Literature
- Public Speaking
- Modern Language (Optional)

Science
- Physics
- Chemistry (Industrial Applications)
- Hygiene and Physical Culture

GENERAL ENGINEERING SUBJECTS

Mechanical Engineering
- Drawing
- Machine Design
- Mechanical Laboratory
- Elementary Power Engineering

Civil Engineering
- Properties of Materials
- Strength of Materials

Electrical Engineering
- Covered in Physics

SPECIFIC SUBJECTS

Human Relations
- Psychology (Optional or P. G.)
- History of Industry
- Philosophy of Industry

Production
- Statistics and Statistical Control
- Factory Organization and Management
- Cost Analysis
- Shop Practice (Principles)

Marketing
- Industrial Relations
- Finance and Marketing (Optional or P. G.)

Finance and Law
- Principles of Economics
- Business Law (Optional or P. G.)
- Economic Problems of Industry

The class hours given in the schedules represent as nearly as possible the actual time spent in lecture room and laboratory excluding all preparation hours. Moreover, no summer work has been included in the figures, as comparative values between institutions under the co-operative plan and those not under the plan would have no significance. Under the heading "General Engineering Subjects," where shopwork or surveying, for example, are given entirely during the summer in one institution and in term time in another, there is naturally a slightly unfair weighting of total hours. This, however, is not serious enough to nullify general comparisons, which is all that is attempted in this presentation

A PROPOSED MANAGEMENT ENGINEERING COURSE

The last course tabulated is a rearrangement of that proposed by a special committee at the Philadelphia convention of The Society of Industrial Engineers in March, 1920. The publication of this course has accomplished a good deal in that it has brought forth comment from various educators as to what really ought to be taught in the training of an industrial engineer.

One says, "I have no quarrel with any one who wishes to give a course under the head of 'Business Management' or a similar title, but I do hold that if any engineering course is given it should contain the fundamentals of engineering, such as calculus, applied mechanics, heat engineering, machine design, etc. I realize also that some men who have not this engineering training may make excellent managers and I shall be very glad to pass such men over to such schools as will give them training in management, but I will object to having their training called engineering and to their receipt of degrees in engineering."

Another writes, "I believe that the foundations of a course in Industrial Engineering should include psychology—principles of human behavior—as well as engineering and economics. Since the detailed course outlined is not heavier than our course in mechanical, electrical, and chemical engineering, I believe the committee's suggestion does not fully utilize the possibilities of a four-year undergraduate course in Industrial Engineering of grade to correspond with the engineering courses now given in technical schools of the first class."

Still another comments as follows: "First, I do not agree at all that calculus should be optional. As a matter of fact, it is not possible for the student to study intelligently a number of the courses listed in your scheme unless he has a knowledge of calculus, unless indeed he is prepared to study these subjects 'parrot fashion,' which, as you are well aware, is not the proper method. My second objection is that I find no mention of analytic mechanics. Analytic mechanics is the keystone of the arch of an engineering course, and furthermore, again, without mechanics many of the subjects that you have listed further along in the course would have to be given in an exceedingly crude and elementary fashion. In other words, I think the course lacks the two subjects which are most important in the training of an engineer."

The quotations given represent opinions at three typical institutions, viz.: Pennsylvania State College, Purdue University, and Cornell University. So far as the course criticized is concerned, it would seem that if the word "optional" be stricken out and the subject of analytical and applied mechanics be added, the

proposed curriculum would not differ in essentials from those with which it is compared.

Referring to Table 1, in the four subdivisions under the heading "Specific Subjects," there seems to be the widest variation in percentages under "Production," with the one exception of Purdue University, under the most representative in the column of "General Subjects," Yale University under the "General Engineering Subjects," and New York University under the "Specific Subjects."

It is the opinion of the writer that in the usual engineering courses at most of our technical schools, the

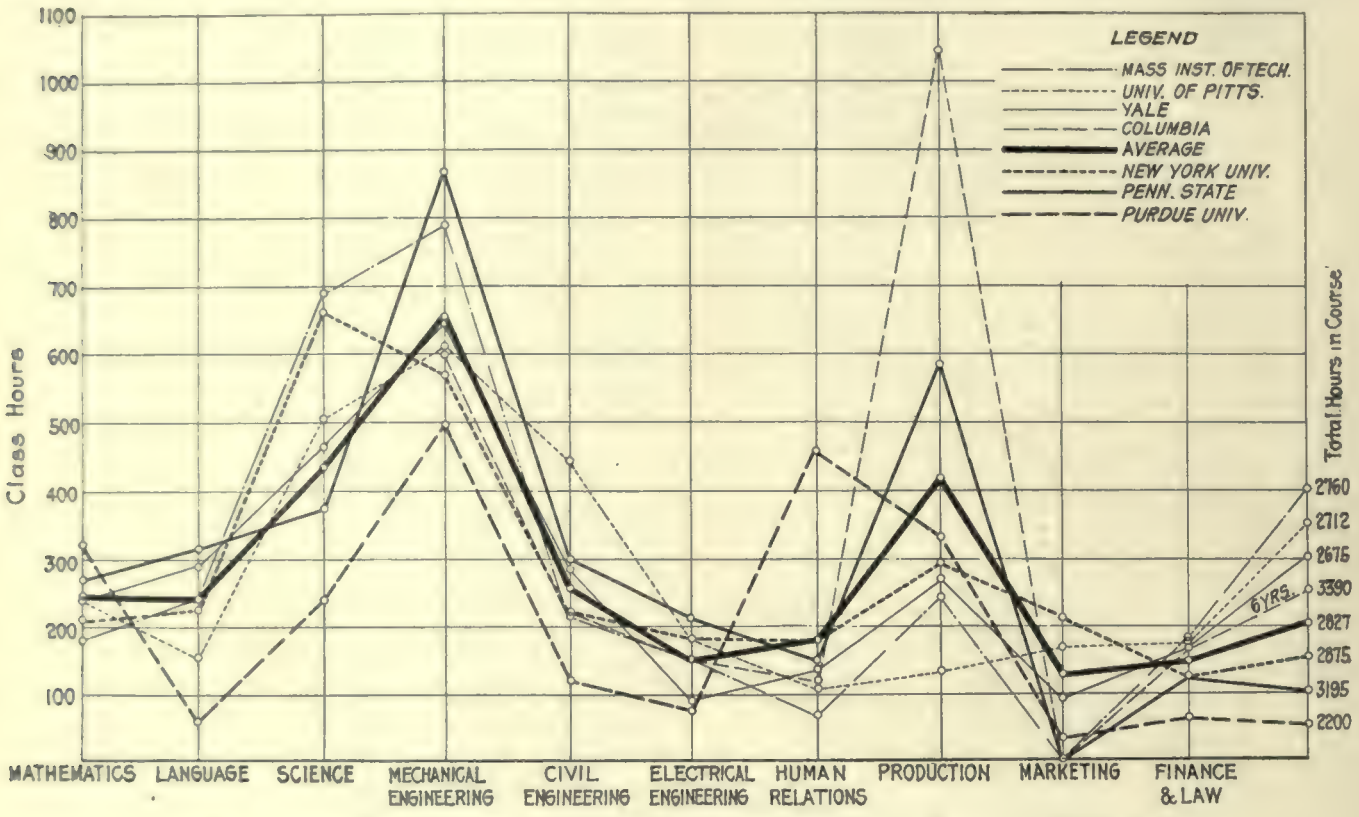

FIG. 1 CHART SHOWING THE NUMBER OF CLASS HOURS DEVOTED TO INDIVIDUAL SUBJECTS AT THE SEVEN INSTITUTIONS LISTED IN TABLE 1

The author is indebted to Professor Gano of the University of Cincinnati for assistance in plotting this chart

TABLE 1 SUMMARY OF THE NUMBER OF HOURS DEVOTED TO INDIVIDUAL SUBJECTS

Institution	General Subjects						General Engineering Subjects						Specific Subjects								Total Class Hours
	Mathematics		Language		Science		Mechanical		Civil		Electrical		Human Relations		Production		Marketing		Finance and Law		
	Class Hours	Per Cent	Class Hours	Per Cent	Class Hours	Per Cent	Class Hours	Per Cent	Class Hours	Per Cent	Class Hours	Per Cent	Class Hours	Per Cent	Class Hours	Per Cent	Class Hours	Per Cent	Class Hours	Per Cent	
Mass. Inst. of Technology	180	6.6	240	8.7	690	25.0	790	28.6	220	8.0	150	5.4	70	2.5	240	8.7	.....	.....	180	6.5	2760
Penn. State College	270	8.4	270[1] 45[1] 200	10.0	375	11.7	870	27.2	300	9.4	210	6.6	150	4.7	585	18.3	.....	.....	120	3.8	3195
Sheffield Scientific School	240	9.0	90[2]	10.8	465	17.4	645	24.2	285	10.6	90	3.5	135	5.0	270	10.0	90	3.2	165	6.2	2675
Columbia University[3]	.....	.....	.....	.....	135[4]	.....	600	17.7	225	6.6	150	4.3	120	3.5	1050	31.0	.....	.....	165	4.8	3390
New York University	210	7.3	225	7.9	660	22.9	570	20.0	225	7.8	180	6.2	180	6.3	295	10.0	210	.4	120	4.2	2875
University of Pittsburgh	240	8.8	156	5.8	504	18.6	612	22.6	444	16.4	180	6.6	108	4.0	132	4.8	168	6.2	168	6.2	2712
Purdue University[5]	330	15.0	60	3.0	240	10.8	495	22.5	120	5.5	75	3.4	460	20.8	330	15.0	30	1.3	60	2.7	2200
AVERAGE	245	8.7	214	7.6	438	15.5[1]	655	23.2	260	9.2	148	5.1	175	6.7	415	14.6	124	4.4	142	5.0	2829

[1]Modern Economic History. [2]History and Government. [3]Six-Year Course—3 years' Industrial Engineering.
[4]This figure represents hours given in the three-year course in addition to those in the preliminary college course.
[5]This figure is made up of the hours indicated plus the average of the hours in the "General Subjects" for the sake of comparing all four-year courses.
[6]Class Hours based on credit hours multiplied by 15.

heading of "Human Relations." The decisions of The Society of Industrial Engineers' Committee on curriculum would indicate that those institutions having the highest percentages under "Human Relations" and "Production develop more nearly the ideal course."

In Table 1 the percentages under the three main headings indicate that the University of Pittsburgh is the curricula are too much alike, and the colleges of engineering ought to be more distinctive in the courses they offer and not all do practically the same thing. It would seem that The Society of Industrial Engineers through its special committee has performed a creditable piece of work in calling attention to the fact that industrial engineering education has at least started right.

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Classifying and Indexing the Clipping File

An Innovation in American Engineering Journalism

By HARRISON W. CRAVER

Director, United Engineering Societies Library

AMONG the minor problems which every engineer and executive has to struggle with is that of filing the clippings from technical magazines, pamphlets, and similar printed matter which accumulate in his office. Everyone has a collection of such literature that he wishes to keep, either temporarily or permanently, and for which some system of classification must be devised which will bring similar material together into groups small enough for convenient examination and use.

This seems a simple problem and one that should be solved with little difficulty; but many have learned by experience that it is hard to hit upon a system that will expand to meet new needs as they arise and at the same time prove adequate for the treatment of large amounts of matter and not require an undue amount of work to maintain. For a file of data of this kind is, after all, usually a convenience rather than a necessity, and economically unjustifiable unless it can be kept up at less expense than that entailed in obtaining needed information from other sources.

An Unlimited Number of Systems

While there is no limit to the possible number of schemes for classifying information, and many individuals have solved the problem with varying degrees of satisfaction to themselves, a decided opportunity exists for the creation of some economical plan whereby articles could be classified and indexed in a uniform manner, thus leaving the user only the task of arranging them in files. Librarians, to whom the classification of literature has always been a directly practical problem, have for generations been devising such schemes and in their numerous experiments they have tried to secure as logical a classification as possible, with a notation that would be simple, economic, and flexible, and at the same time provide for the insertion of new subjects at any point whenever necessary. Unfortunately, however, some of these desires are mutually contradictory, and the reason why no general agreement as to the comparative merits of various schemes has been possible is that individual opinions differ concerning the relative importance of the qualities which are to be desired.

Although much careful thinking has been done and much has been written on the subject, no system of classification has been universally accepted, although there have appeared during the past thirty years, several systems that have found general favor and have been widely adopted. Of all of these systems the decimal classification has undoubtedly found the greatest favor and is most universally used.

Widespread Use of the Decimal Classification

The decimal classification was published by Melvil Dewey in 1876 in a modest pamphlet providing one thousand classes. Attached to it was a relative index to the tables by which all the aspects of any subject in the schedules could be quickly located. This index which, rather than the classification, Dewey considered his important contribution, undoubtedly did much to popularize the scheme, for the classification spread rapidly and new editions and new divisions of the tables were demanded frequently. It became the most used system in America, soon spread to England, and attracted attention in Continental Europe. Upon the organization of the Institut International de Bibliographie, about twenty-five years ago, an exhaustive study of classification was conducted, which resulted in the adoption of the Dewey system.

The French edition of this classification, prepared and issued by the Institut, is a "monument of minute research and special knowledge." While the work already done was not changed, the classes were greatly expanded and certain "form" divisions added which made it possible to classify accurately small and specific literature dealing with more minute topics than books. With the modifications and addenda supplied by the Institut, it is possible to attain a remarkable degree of precision; in fact, it is frequently difficult to know when to stop and a classifier with a poor sense of proportion may easily carry classification far beyond all reasonable requirements.

Applying the System to Engineering Literature

The Dewey classification divides the field into ten main classes, represented in the notation by the decimal system of Arabic numerals. Human knowledge is divided into nine classes, each being given a decimal number as .1, .2, .3, etc., and the numbers beginning with .0 are reserved for encyclopedias, newspapers and other material too general in inclusion to be assigned to a specific class. Each main class can therefore be represented by a single numeral. Subdivision is always accomplished by tens, so that all numbers being decimals these subdivisions can be marked by adding an additional numeral to some existing number.

The result in application of such a system is accordingly somewhat as follows:

.6	Applied Science
.62	Engineering
.624	Structural Engineering
.6243	Trusses
.62435	Cantilever Truss

Something more is needed, however, by a user of literature, for frequently he wishes to group material from a certain point of view. One, for example, may wish to arrange the subject historically, another geographically. Again one may wish to group commercial statistics by countries, another by industries or products. To meet these various needs is the object of the "form" divisions invented by the Institut International de Bibliographie. These consist of a few arbitrary symbols, that are filed in a fixed arbitrary sequence. It would be wearisome to explain these signs here, but the following examples of their use may be of interest as showing their possibilities.

.62113	Locomotives
.62113(02)	Treatises on the locomotive
.62113(44)	Locomotives in France
.62113"19"	Twentieth century locomotives
.62113:622	Locomotives in mining
.62113B	Baldwin locomotives
.62113 0014	Locomotive tests
.62113 04	Locomotive boilers
.62113 42	Locomotive valve gears

It might be well in passing, however, to call particular attention to the relation sign, the colon, : which is perhaps the most important of the symbols adopted. When used in the classification to join two numbers it indicates that the subjects represented by them are considered in relation to each other. It enables us to extend the classification to great lengths in order to express relations without having to provide the apparatus in advance. Taking, for example, the number for the woodworking industries, 674, and the number for management engineering, 658, we can form the combination 674:658, representing the management of woodworking industries.

The system makes it equally easy to arrange material by the point of view, so that theory, tests, costs, and similar topics will be grouped together. In fact, if thoroughly mastered, it enables the user to attain any grouping that his needs demand. In practice it is usual to omit the decimal point when writing the numbers. It is also customary to divide long numbers into groups by inserting periods, which have no significance except to make it easier to read the numbers. In filing, every number is considered a single decimal.

Adoption by Engineering Societies Library

This, in brief outline, is the system. It is impossible, however, to give any idea of its remarkable possibilities without going into considerably more detail than the average reader will care to have. The important question is how it can be made of value to him.

Some three years ago a careful study was made of the needs of the United Engineering Societies Library, and the scheme that seemed best adapted to meet those needs was the Dewey classification as extended and modified by the Institut, usually known as the "Brussels" classification. This system was at length adopted, and since then the work of classifying and re-indexing the matter in the United Engineering Societies Library has been steadily going forward. When this work is completed the library will contain the most extensive grouping of classified engineering literature in the United States.

An incidental advantage of the "Brussels" classification is its widespread use, and in this connection it is interesting to note that a number of Belgian and French technical magazines classify the abstracts which they publish, incorporating as a part of the title the index entry and index symbol. Before the war several European organizations classified their literature in the same manner. This shows the international acceptance of the system and its principles, and indicates that its notation is quite generally understood.

In contrast to this practical use of the "Brussels" classification, no American engineering publication up to the present time has ventured to classify and index its articles in this manner, although the advantages from such a course would seem self-evident to anyone desiring to clip and preserve matter of permanent value to him.

Classification Plan of Management Engineering

As classification is a specialty in itself and an intricate one, it would seem sensible to centralize the work, have it done by experts, and distribute their decisions to the individual user. If, for example, a classification symbol be printed with each article that appears in a periodical, it will not be difficult for anyone to build up a consistent file. All the user need do is file the article by the number and prepare an index to these numbers, full enough for his requirements. The index will be the only key to the classification that he will need.

This centralized classification of articles is what Management Engineering offers. Each article will have its number, referring to the division in the decimal classification, usually to class 658, Management Engineering. By filing each article according to its number a collection of clippings will be built up with little effort. The idea is interesting and the intent most praiseworthy. It should result in a usable file of data, readily accessible, formed and maintained with a minimum of trouble. As it develops, it will be easy to insert clippings from other sources by copying the proper numbers from similar articles already filed.

As one to whom the question of classification has been a matter of concern for many years, the writer is deeply interested in this forward step, which he hopes to see become a general practice among engineering magazines. It seems a sensible way to ameliorate the difficulty which has long confronted everyone who has tried to file material.

Clippings *029.3*
Classification *025.4*

How to Use the Indexing System of Management Engineering

IN order that the articles published in MANAGEMENT ENGINEERING may be made quickly and easily available a system of indexing new to American technical journalism has been adopted. The system is not untried, however, for it is the one employed by the Engineering Societies' Library of New York for the cataloguing of its 150,000 volumes on engineering and related subjects. This library is perhaps the best of its kind in this country, if not in the world.

The broad features of this new system of indexing are described by Harrison W. Craver, director of the Engineering Societies' Library, in an article "Classifying and Indexing the Clipping File," which appears on page 49 of this issue. Mr. Craver, however, does not cover in detail the manner of using the index as adopted for a periodical such as MANAGEMENT ENGINEERING and so the following explanation has been prepared.

674:658

AUTHOR Churchill, W. L.

TITLE "Yield Value" Variation in Woodworking

REFERENCE Management Engineering, vol. 1, page 17

CARD 1. AN ENTRY IN THE NUMERICAL INDEX

HOW THE INDEX IS USED

The cataloguing of an article or book requires that it be (1) classified, (2) indexed, and (3) that a reference card or cards be made and filed. The first two operations are the work of an expert, the last is but a mechanical job. All the articles of MANAGEMENT ENGINEERING will be classified and indexed by the cataloguing staff of the Engineering Societies' Library and thus all the reader of the journal need do is to prepare his card index or clipping file as briefly described below.

The creation of an accumulative card index is best explained by showing its application in a specific case. Turning, therefore, to the article, "Yield Value Variations in Woodworking," by W. L. Churchill, which appears on page 17, we find at the top of the page two headings which read:

Woodworking industries. Management. 674:658
Management engineering. Woodworking industries.....658.9:674

The significance of these two lines is as follows:

The words on the left are the key to the classification of the article and the numbers on the the right are the indexing symbols. Taken together the two are known as a "subject entry." The numbers are the important part of the scheme as they stand for the subject which the phrase expresses, that is, the number 674 in the first line indicates the woodworking industries, and the number 658, management engineering, so the combination 674:658 is the symbol which tells us that the article is indexed from the woodworking point of view. Similarly, the second line indexes the article from the management point of view—658.9 management engineering, and 674 woodworking industries.

CREATING AN ACCUMULATIVE CARD INDEX

If, therefore, cards are made out containing the indexing symbol, the name of the author, the title of the article, and the volume and page number for each article in MANAGEMENT ENGINEERING (where there is more than one indexing symbol separate cards must, of course, be made out for each) and are filed numerically, an index will be started, so arranged and classified that all of the articles on any one subject will be found together under one number. To locate an article an alphabetical index must, of course, also be created and this is done by making out cards carrying both the key words and indexing symbols given at the beginning of each article.

Inasmuch, however, as many key words may be employed, only one will be printed at the heading of each article as an interpretation of the indexing symbol, and in what is known as the "relative index" (that for this issue appearing on page 64). All the key words will be found in convenient alphabetical arrangement. This relative index thus enables one to find the material he is seeking regardless of the key word selected.

658.9:674

AUTHOR Churchill W. L.

TITLE "Yield Value" Variation in Woodworking

REFERENCE Management Engineering, vol. 1, page 17

CARD 2. AN ENTRY IN THE NUMERAL INDEX

For example, suppose the key word thought of in seeking information on woodworking had been "Lumber industries" instead of "Woodworking industries." By turning to the relative index, we find the entry:

Lumber industries. Management.....674:658

which gives us the same indexing symbol, and consequently, the same article as our previous entry, namely:

Woodworking industries. Management..674:658

The numerical index as it becomes accumulative from month to month will thus show what articles on any given subject have been published, and such articles may then be found by the alphabetical index.

The above scheme of indexing is accordingly so simple in its application that an accumulative card index to MANAGEMENT ENGINEERING can be easily started and maintained with but a small amount of work if the following directions are carefully followed:

1. Copy on card for each article in the issue (a printed form such as is shown by Card 1 may be used) the name of the author, the title of the article, and the volume and page number. Add in the upper right-hand corner the number given at the head of the article.
2. If there is more than one number at the head of an article, make additional cards exactly like the first, only place in the upper right-hand corner the additional number printed at the head of the article. (See Card 2.)
3. File all such cards numerically.
4. Next turn to the relative index and copy each subject entry on a card followed by its number. (See Cards 3, 4, and 5.)
5. File all these cards alphabetically.

Lumber industry.
Management 674:658

Management engineering.
Woodworking industries 658.9:674

Woodworking industry.
Management 674:658

CARDS 3, 4, 5. ENTRIES IN THE RELATIVE INDEX

INDEXING THE CLIPPING FILE

Turning now to the second way in which the indexing system of MANAGEMENT ENGINEERING may be used, *i.e.*, its application to the clipping file, it is obvious that such a file may be indexed according to the above outlined scheme if the clipping itself be used in the place of one card, and the other cards carry an additional line giving the cross reference. Thus in the case under discussion, the clipping takes the place of Card 1, and Card 2 is modified by the addition of a line reading "Clipping Filed Under 674:658," as shown by Card 6. An alphabetical index as before is of course also necessary. A suggested method of keeping both clipping and cross-reference card is shown by Figs. 1 and 2.

The alphabetical key cards containing the subject entries need, of course, to be made out but once, for they are the sign posts which point the way. Further-

658.9:674
AUTHOR W. L. Churchill
TITLE "Yield Value" Variations in Woodworking
REFERENCE Management Engineering, vol. 1, page 17
CLIPPING FILED UNDER 674:658

CARD 6. A CROSS-REFERENCE CARD FOR THE CLIPPING FILE

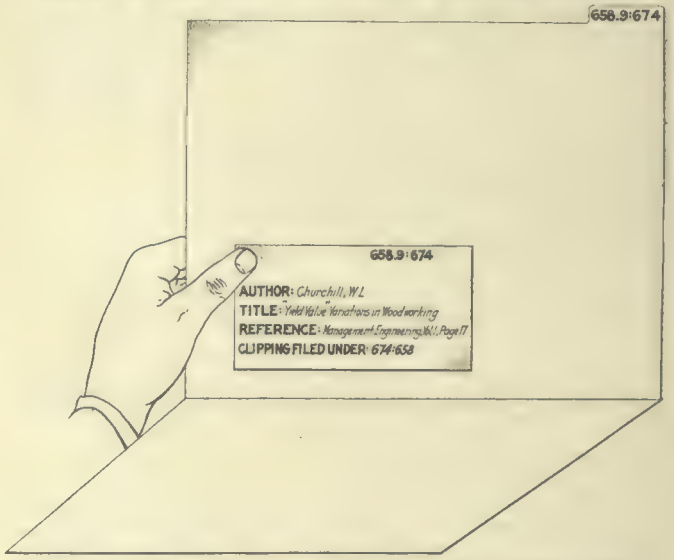


FIG. 1 A CROSS-REFERENCE CARD IN THE CLIPPING FILE

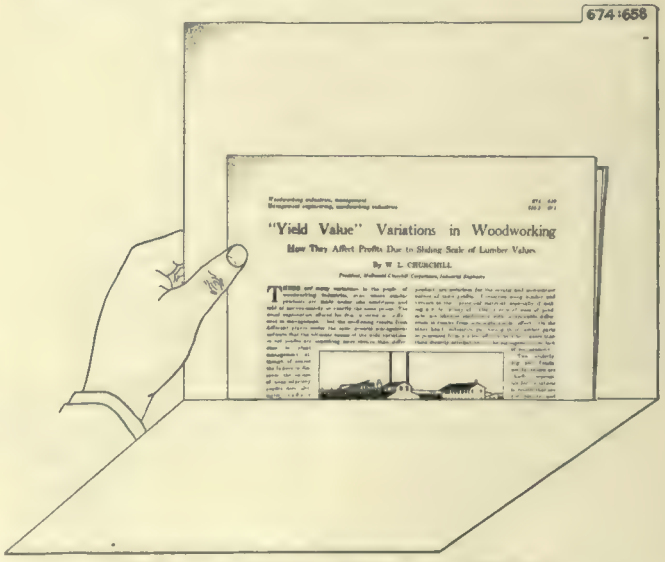

674:658
"Yield Value" Variations in Woodworking
How They Affect Profits Due to Sliding Scale of Lumber Values
By W. L. CHURCHILL

FIG. 2 AN ARTICLE FILED AND INDEXED

more, it will be found that as the index grows, the numerical file becomes a logical catalogue of subjects and not only do all the articles on like subjects fall together, but likewise related subjects appear in their proper sequence.

THE LABOR SUMMARY
Statistics and News from Industry

The Status of Unemployment in the United States

UNEMPLOYMENT in the industries of the United States is on the increase according to test surveys conducted by the Employment Service of the United States Department of Labor. The figures, which are the most complete obtainable from any one source, show that in January of this year there were 6,070,648 workers employed as compared with 9,402,000 in January, 1920, or a decrease of 35.5 per cent. This limited survey covered 35 states and 182 industrial cities and centers, and may be considered as fairly reflecting conditions at that time. Table 1 gives the detailed results of this survey for the various industrial groups covered.

TABLE 1. THE STATUS OF UNEMPLOYMENT IN AMERICAN INDUSTRIES, JANUARY, 1921
(Compiled by the U. S. Employment Service, U. S. Department of Labor)

Industrial Group	Number Employed Jan. 1920	Number Employed Jan. 1921	Decrease	Per Cent
1. Metals and products, machinery, electric goods, foundry products	2,870,956	1,997,862	873,094	69.5
2. Building trades	1,067,572	508,322	559,250	47.6
3. Packing and food products	1,111,421	900,941	210,480	81
4. Textiles and products, clothing hosiery and underwear	1,819,596	1,175,086	644,510	64.5
5. Leather, its products, boots and shoes	417,209	271,931	145,278	65.1
6. Automobiles and accessories	780,340	240,413	539,927	30.8
7. Lumber, house furniture, boxes, wood products	793,424	538,766	254,658	67.8
8. Clay, glass, cement, and stone products	541,482	437,327	104,155	80.7
Total	9,402,000	6,070,648	3,331,352	64.5

Since January, 1921, the United States Employment Service has regularly collected data relative to employment on a somewhat more restricted scale, covering only those firms which have 500 or more on the payroll. Of these firms there are but 1,424 reporting to the Employment Service, and for the month ending May 31, returns were made showing 1,573,538 workers employed as compared to 1,628,134 on January 31, a decrease of 54,596, or approximately 3.3 per cent. The decrease for the month of May alone totals 7,211 workers, or approximately ½ per cent.

The figures compiled by the Employment Service are collected and tabulated both by industries (the 14 industrial groups set up by the United States Census being used as a basis) and by geographical districts. Table 2 shows the number employed in the various industries, from January to May, 1921, and Fig. 1 presents this information in graphic form. Fig. 2 shows the geographical distribution.

As the charts clearly indicate, the iron and steel industry shows the greatest loss of workers, there being a decrease of 98,796 at the end of May as compared with the month of January. Industries manufacturing vehicles for land transportation, on the other hand, show an almost corresponding increase, as there were 87,622 more workers employed in these industries in May than in January.

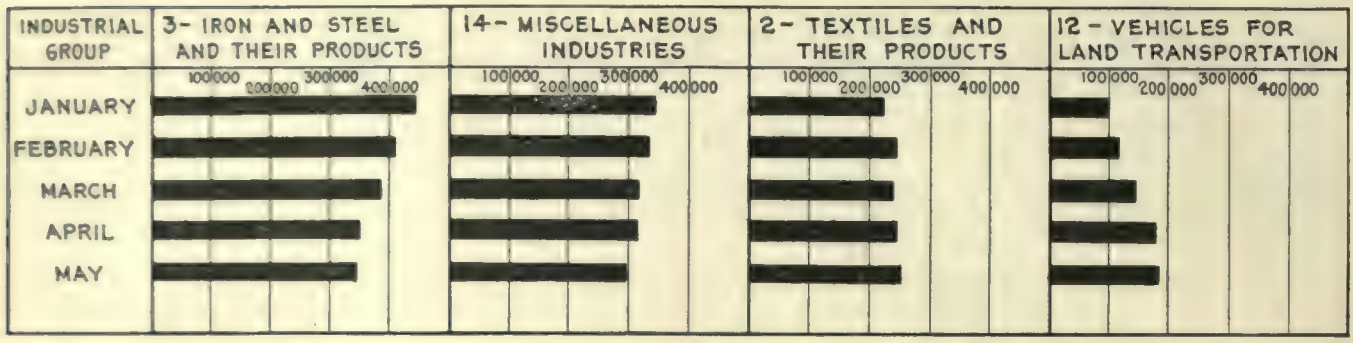
With respect to changes for the month just past, April 30 to May 31, seven industries (tobacco manufacture, miscellaneous industries, lumber, iron and steel, food, chemicals, and metal industries other than iron and steel) show an increase of 27,383 workers; while the remaining seven (railroad repair shops, leather, vehicles for land transportation, textiles, stone, clay and glass, and paper and printing) show an increase of 20,172, the net loss thus being 7,211.

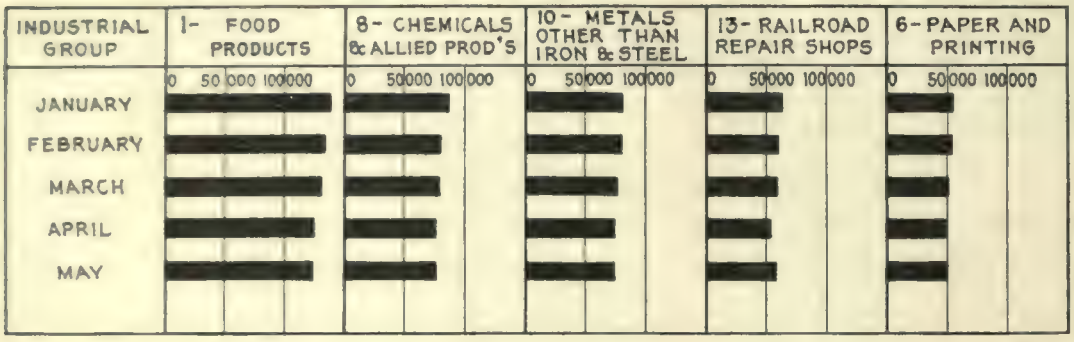
Changes in employment have been most marked in the Middle Atlantic District (N. Y., N. J. and Pa.), there being a decrease of 73,174 as compared with January. Only one district, the East North Central (Ohio, Ind., Ill., Mich. and Wis.), shows an increase, the rise to the end of May being 48,132.

In addition to its statistical information the United States Employment Service is making available, through its bulletin, current comment on items of general interest affecting employment. From this news comment section the following paragraphs have been prepared as further indicating the trend of employment:

New England District. In this district there is a large amount of unemployment in metals and building, though industrial settlements in the building trades may tend to stimulate that line. The shoe and leather industry is erratic. Lumber, paper, and stone are not responding to treatment. In textiles, on the other hand, cotton seems temporarily stabilized, with mills averaging fair business, particularly in sheetings, ginghams and napped goods. Woolens are running maximum for the season, having business until early summer.

Middle Atlantic District. During the past month the industrial situation in this section showed little change, unemployment continuing to be serious in almost every city. Automobile industries here do not show as marked an increase in activity as during the previous two months, and iron and steel are very inactive. Textiles, however, seem to be holding their own.





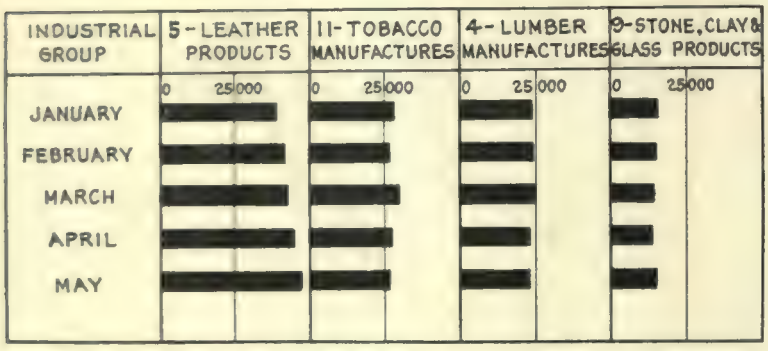


FIG. 1 HOW EMPLOYMENT HAS VARIED IN THE INDUSTRIES OF THE UNITED STATES SINCE JANUARY, 1921

TABLE 2. NUMBER OF WORKERS EMPLOYED IN 1424 AMERICAN INDUSTRIES, JANUARY TO MAY, 1921, TABULATED ACCORDING TO INDUSTRIAL GROUPS

(Compiled by The U. S. Employment Service, U. S. Dept. of Labor.)

INDUSTRIAL GROUPS	NUMBER ON PAYROLL				
	Jan. 31	Feb. 28	March 31	April 30	May 31
1. Food and kindred products	137,444	134,757	131,065	125,725	124,810
2. Textiles and their products	223,705	242,854	238,542	247,137	253,743
3. Iron and steel and their products	443,754	410,773	383,794	353,739	344,958
4. Lumber and its manufacture	24,018	24,507	24,599	23,496	22,814
5. Leather and its finished products	39,385	42,441	43,185	45,236	47,178
6. Paper and printing	52,865	51,838	50,371	49,693	49,916
7. Liquors and beverages	1,747	1,646	1,654	1,660	1,691
8. Chemicals and allied products	84,803	79,676	78,116	76,291	76,186
9. Stone, clay and glass products	15,102	14,787	14,378	13,921	14,197
10. Metals and metal products other than iron and steel	79,664	79,887	76,282	74,574	74,571
11. Tobacco manufacturers	28,279	27,797	30,176	27,980	26,438
12. Vehicles for land transportation	93,852	111,536	142,878	174,864	181,474
13. Railroad repair shops	63,118	58,911	57,584	53,616	58,100
14. Miscellaneous industries	340,398	331,201	315,162	312,817	297,462
Totals	1,628,134	1,612,611	1,587,786	1,580,749	1,573,538

Building construction still awaits adjustment of existing industrial controversies.

East North Central District. Retail buying is cautious in the East North Central District, and as a result business in general continues to lag. It is believed that a marked change for the better cannot be expected until some intelligent organized effort at improvement is made. Such matters as the readjustment of costs of construction and manufacture, stimulation of retail trade in order to move accumulated stocks, and some means of improving the foreign demand, are the important problems.

West North Central District. It is conceded that the rate of improvement apparent in April in this district was not maintained during May, though seasonable weather toward the end of the month has had a stimulating effect. There are certain bright spots in the situation, however, such as the boot and shoe industry, which is increasingly busy. In many cities the local commercial organizations are conducting trade campaigns for the wholesalers into the surrounding territory, and export trade is brightening in certain other lines.

South Atlantic District. While some industries in the South Atlantic District continue to show reduced employment and unsatisfactory conditions, in others the reverse is true, the net result being an improvement over the previous month. Lumber and its products display a gratifying increase in employment, amounting, from the figures in hand, to over 8 per cent. Following important labor adjustments, building also shows distinct improvements. On the other hand, fertilizers are showing seasonal slackness. The con-

sensus of opinion is that the gradual improvement in the employment situation will continue, but that much depends on the satisfactory settlement of transportation problems.

East South Central District. There has been little or no change for the better in employment conditions throughout this district during the past month. Retail business, however, is improving, and reports from a number of establishments indicate practically normal conditions.

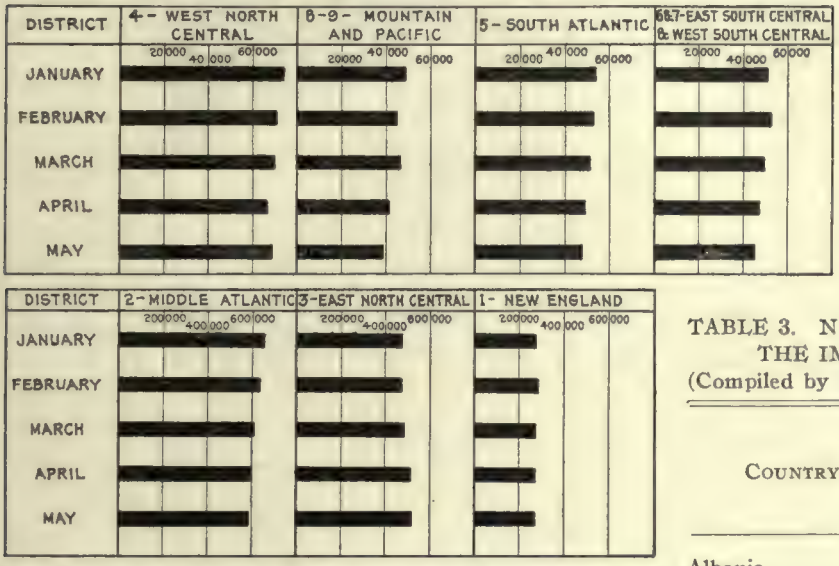


FIG. 2 HOW EMPLOYMENT HAS VARIED THROUGHOUT THE UNITED STATES SINCE JANUARY, 1921

4—West North Central District
(Minn., Iowa, Mo., Neb., Kan.)
8-9—Mountain and Pacific District
(Col,. Wash., Ore., Cal.)
5—South Atlantic District
(Md., Va., Ga.)
6-7—East South Central and West South Central Districts
(Ky., Tenn., Ala., La.)
2—Middle Atlantic District
(N. Y., N. J., Pa.)
3—East North Central District
(Ohio, Ind., Ill., Mich., Wis.)
1—New England District
(N. H., Mass., R. I., Conn.)

West South Central District. Gradual but steady improvement characterizes the general situation in this district. Commercial building in some sections is quite active, despite a reluctance on the part of investors to finance construction projects, while costs remain at the present levels. Lumber shows an improvement apparently in excess of mere seasonal activity. Merchandising is active, and organizations looking toward the extension of foreign credits are busy, with a consequent increase in exports.

Mountain District. In localities where mining and allied industries constitute the principal source of employment, conditions are depressed. City retailing, however, shows a downward trend in nearly all lines, as indicated by total receipts, though owing to the volume of sales the personnel has not been greatly affected. Increased railroad operations are most noticeable on the central and northern routes, and building activities are principally confined to the smaller cities.

Pacific Division. While the employment situation in this district has improved during the month, unemployment is still prevalent. Despite a decreased demand for lumber, which has curtailed forces in forests and mills, there has been an increase in home building, particularly in Portland and Los Angeles. Moreover, the number of new industries has increased, notably in Los Angeles and Oakland, oil drillings recorded this year exceeding 500, and shipments by water indicating a large volume of business.

New Immigration Law Now in Effect

THE new immigration bill recently passed by Congress went into effect on June 3. It restricts the number of immigrants to 3 per cent of the nationality already here, and under such terms a total of 355,825 immigrants will be allowed to enter during the year 1921. The distribution among the various nationalities is made on the basis of the 1910 census, and Table 3 shows the number apportioned to each country. The bill remains in force until June 30, 1922.

The bill further provides that the number to be admitted during any month may be as high as 20 per cent of

TABLE 3. NUMBER OF ALIENS ADMISSIBLE UNDER THE IMMIGRATION ACT OF MAY 19, 1921.
(Compiled by Bureau of Immigration, U. S. Dept. of Labor)

COUNTRY OR PLACE OF BIRTH	QUOTA FISCAL YEAR 1921-22	LIMIT PER MONTH FISCAL YEAR 1921-22
Albania	287	57
Austria	7,444	1,489
Belgium	1,557	311
Bulgaria	301	60
Czechoslovakia	14,269	2,854
Danzig	285	57
Denmark	5,644	1,129
Finland	3,890	778
Fiume	71	14
France	5,692	1,138
Germany	68,039	13,608
Greece	3,286	657
Hungary	5,635	1,127
Italy	42,021	8,404
Jugoslavia	6,405	1,281
Luxemburg	92	18
Netherlands	3,602	720
Norway	12,116	2,423
Poland	20,019	4,004
Eastern Glacia	5,781	1,156
Portugal (including Azores and Madeira Islands)	2,269	454
Roumania	7,414	1,483
Russia (including Siberia)	34,247	6,849
Spain	663	133
Sweden	19,956	3,991
Switzerland	3,745	749
United Kingdom	77,206	15,441
Other Europe (including Andorra, Gibraltar, Lichtenstein, Malta, Monaco, San Marino, and Iceland)	86	17
Armenia	1,588	318
Palestine	56	11
Smyrna District	438	88
Syria	905	181
Other Turkey (Europe and Asia)	215	43
Other Asia (including Persia and territory other than Siberia which is not included in the Asiatic Barred Zone. Persons born in Siberia are included in the Russia quota)	78	16
Africa	120	24
Australia	271	54
New Zealand	50	10
Atlantic Islands (other than Azores, Madeira, and islands adjacent to the American Continents)	60	12
Pacific Islands (other than New Zealand and islands adjacent to the American Continents)	22	4
Total	355,825	71,163

the total number who are admissible during the fiscal year. This provision thus makes it possible for the entire number admissible under the law to be admitted in five months, thereby preventing further immigrants from entering during the balance of the year.

The enforcement of the new law is causing a considerable amount of confusion and trouble, as the quotas for several countries have already been exceeded. It is expected, however, that the problem will be met by permitting those en route to enter, making the necessary adjustments of quotas during the remaining months.

The Trend of the Cost of Living in the United States

INFORMATION concerning the cost of living in the United States has lately assumed a new importance because of its intimate relation to the question of wage increases. Many agencies are engaged in collecting and compiling data relative to living costs, and a study of their statistics shows that prices reached their peak in July, 1920, and have since steadily declined, until at the present time they are approximately 65 per cent above the pre-war levels of 1914.

The figures compiled by the National Industrial Conference Board (New York) are enlightening, as they show the changes in the retail cost of the items which go to make up an average family budget. According to the board the average family expenditure is:

Food	43.1 per cent
Shelter	17.7 " "
Clothing	13.2 " "
Fuel and Light	5.6 " "
Sundries	20.4 " "
	100.0 " "

The changes in these five items have been followed by the National Industrial Conference Board since July, 1914, and their findings, which cover representative conditions throughout the United States, are given in Table 4. Clothing, it will be noticed, reached the highest peak of all at 177 in March, 1920, and has since steadily declined. Food, fuel and light, and sundries also show a decline, dropping respectively 26, 22, and 7 per cent from their peak values. Shelter, on the other hand, shows an increase, the rise since January, 1921, being 5 per cent.

All the figures combined and weighed according to the consumption stated above give, however, a lowering cost of living. Fig. 3 shows this in graphic form.

RETAIL FOOD PRICES

The changes in the prices of food as reported by the National Industrial Conference Board, are based upon figures compiled by the United States Bureau of Labor Statistics. This Bureau has for many years regularly collected data showing the retail prices of the 22 principal articles of food consumed by the average American family. The monthly fluctuation in these prices is plotted in Fig. 3, and, as might be expected, the trend closely follows that of the total cost of living. The index number now stands at 152, as compared with an average price of 100 for the year 1913, while the drop from the peak reached in June, 1920, has been 67 per

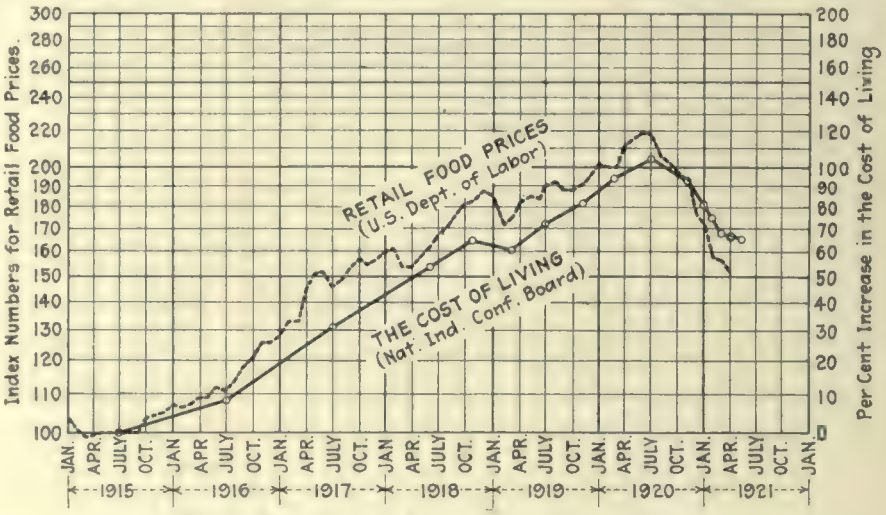


FIG. 3 THE COST OF LIVING IN THE UNITED STATES

The heavy curve shows percentage increases in the cost of the items which go to make up the average family budget. The light curve shows monthly variation in the 22 articles of food consumed by the average American family.

TABLE 4. PER CENT CHANGES IN THE COST OF LIVING IN AVERAGE AMERICAN COMMUNITIES BETWEEN JULY, 1914 AND MAY, 1921
(Compiled by the National Industrial Conference Board.)

INCREASE IN THE COST OF LIVING BETWEEN JULY, 1914, AND	ALL ITEMS (weighted)	FOOD[1]	SHELTER	CLOTHING	FUEL AND LIGHT	SUNDRIES
July, 1915	0.5	no change	no change	3	2	no change
July, 1916	8.7	11	1.5	20	4	4
July, 1917	31.3	46	5	43	26	17
June, 1918	52.2	62	15	77	35	50
November, 1918	65.0	83	20	93	40	55
March, 1919	60.5	75	22	81	42	55
July, 1919	72.2	90	28	100.	42	63
November, 1919	82.2	92	38	135	48	75
March, 1920	94.8	100	49	177	49	83
July, 1920	104.5	119	58	166	66	85
November, 1920	93.1	93	66	128	100	92
January, 1921	81.2	78	66	87	100	92
February, 1921	76.3	72	66	74	98	90
March, 1921	68.7	56	71	74	87	85
April, 1921	67.6	56	71	69	79	85
May, 1921	65.7	52	71	68	78	85

[1]Food price increases are computed as increases above average prices in the year 1913, not July, 1914.

cent. Retail food prices are still, however, 52 per cent above the pre-war prices of 1914.

WHOLESALE FOOD AND COMMODITY PRICES

Wholesale food prices are also on the decline, and Fig. 4 shows the monthly fluctuation since 1914. The figures from which the curve was plotted are those regularly compiled by *The Analist* (New York). Twenty-five articles of food, weighted according to their consumption, are used in making up the index number, and the prices are those which prevail on the New York and Chicago markets.

It should be noticed that the average price for the 10-year period 1890-99, has been taken as the base (100), and that, therefore, the peak of 321 reached during May and June, 1920, if measured in terms of 1913 as 100, would be 271. The index number for May stands at 167, or, on the basis of 1913 as 100, at 117.

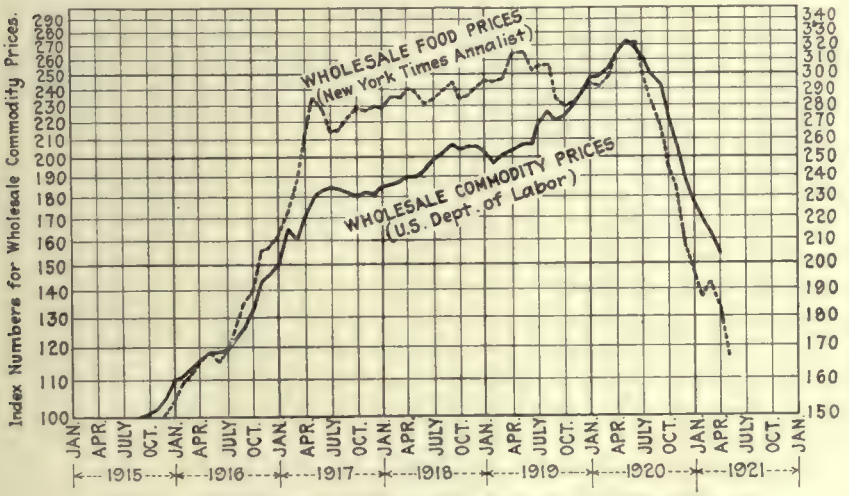


FIG. 4 THE TREND OF WHOLESALE PRICES IN UNITED STATES

The heavy curve shows how the prices of 327 commodities have varied since 1914. The light curve indicates the trend of wholesale food prices.

As a further indication of the trend of the cost of living, a curve of the wholesale prices of commodities is also presented in Fig. 4. The figures from which this curve was plotted are those compiled by the United States Bureau of Labor Statistics, and the index number is made up from the price quotation of 327 commodities. Table 5 shows how the prices of groups of these commodities have varied since January, 1921. As with the other curves, the peak of wholesale commodity prices was reached in May, 1920, the index number being 272, referring to 1913 as a base of 100. The index number now stands at 154.

TABLE 5. RELATIVE WHOLESALE PRICES OF COMMODITIES IN THE UNITED STATES, JANUARY TO APRIL, 1921

(Compiled by the U. S. Bureau of Labor Statistics—Average Price for the year 1913=100.)

COMMODITY GROUP	JAN.	FEB.	MAR.	APRIL
Farm Products	136	129	125	115
Foods, etc	162	150	150	141
Cloths and Clothing	208	198	192	186
Fuel and Lighting	228	218	207	199
Metal and Metal Products	152	146	139	138
Building Materials	239	222	212	203
Chemicals and Drugs	182	178	171	168
House Furnishing Goods	283	277	275	274
Miscellaneous	190	180	167	154
All Commodities	177	167	162	154

Swift and Company Hold Elections Under Employees Representation Plan

SWIFT AND COMPANY recently conducted in 14 of its plants elections for representatives to its employees' assemblies. These elections were held in 11 states, and the results showed that 83 per cent of the employees participated; a high percentage considering the proportion of illiterate employees in the industry.

The Swift Employees' Representative Plan provides for an assembly composed of equal numbers of elected representatives of the employees and appointed representatives of the management. The assembly makes recommendations relating in the main to wages and working conditions. When decisions are reached by a two-thirds vote they are sent to the management, and unless within 14 days the board of directors or the employees' representatives themselves, request further consideration, the decisions are binding. The plan is based on the principles below:

1. Proportional representation of Plant Department in the Assembly with no discrimination as to Employees' Representatives' affiliations.
2. Equal voting power at all times of Employee and Management Representatives both in Committees and Assembly.
3. Procedure by Joint-conference and joint voting on all issues.
4. Submission of any difference on any employment condition, individual or group, in the first instance to the foreman and regular plant authorities.
5. Submission of any unadjusted difference on any employment condition, in the second instance, to the Employee and Management Representatives for the voting division of the plant in which the party or parties are employed; and, failing a unanimous decision, submission to the Committee concerned.
6. Unanimity in every Committee essential to a binding decision.
7. Submission to the Assembly of all joint issues not settled in Committees and a decision to be effected by two-thirds vote.
8. Right of any minority of the Assembly to have one reconsideration of a decision but no further delay except by general consent in the Assembly.
9. No provision for arbitration in the Plan, but no specific exclusion of it as a possible means of settlement by joint consent outside of the Plan.
10. No direct veto of an Assembly decision by Management or Employees without recourse to joint conference for reconsideration.
11. Clear indication in the Plan of the consequences of ultimate failure to arrive at a collective agreement under the Plan on any one issue, and of the right of parties then to take such action, either jointly or separately, outside of the Plan, as they may think desirable.
12. The Plan not to be terminated because of failure to arrive at a collective agreement on any one issue before the Assembly.

MANAGEMENT ENGINEERING

THE JOURNAL OF PRODUCTION

L. P. ALFORD, *Editor*
E. W. TREE, *Associate Editor*

Published Monthly by The Ronald Press Company, 20 Vesey Street, New York.

MANAGEMENT ENGINEERING

TO serve those who are responsible for the operation of industry, MANAGEMENT ENGINEERING has been founded. Our civilization in these opening decades of the twentieth century is based firmly upon modern industry. As this great man-made tool for the production of goods is used well or ill, in like degree do the people benefit or suffer hardship. Merely to operate industry as well as before is insufficient; we must have a continually increasing volume of goods to satisfy the need of an increasing population and to maintain the steady rise in the standard of living. Failure in production, or any serious slowing up, means literally infinite suffering.

To achieve this result, industry must be managed better than ever before. The men who must bring this to pass are the executives. They are responsible for decisions; they give the orders; the approval or blame for the final result must rest upon them.

MANAGEMENT ENGINEERING seeks to help these executives—the men of management—better to discharge their duties in preparing, organizing, and directing industry to secure maximum production. To this aim the Journal of Production is dedicated.

The Breadth of Engineering

THE year 1920 stands forth and will be long remembered in the history of American engineering. In June was held the organizing conference in Washington which prepared the way for the overarching national engineering organization formed in November. In the latter month The Federated American Engineering Societies came into being through the convening for the first time of its governing body, The American Engineering Council. The constitution of this greatest of the world's engineering bodies, drafted and accepted in June by delegates representing 110,000 engineers and adopted with slight modifications in November, stands by itself among all similar documents for its declaration of disinterested service to the State and nation, and for its acceptance of the principle of publicity for all the acts of the organization and its subdivisions.

> The object of this organization shall be to further the public welfare wherever technical and engineering experience are involved, and to consider and act upon matters of common concern to the engineering and allied technical professions.

By accepting this purpose, the engineers brushed aside their traditional aloofness, overcame their own individualism, united for collective action, and prepared to give their best to society at large. But they did more than this. They recognized the broadened field of engineering by writing into the first sentence of the preamble of the Constitution this definition:

> Engineering is the science of controlling the forces and of utilizing the materials of nature for the benefit of man and the art of organizing and directing human activities in connection therewith.

The first part of this statement is but a repetition of the traditional thought of what engineering has always been: "Engineering is the science of controlling the forces and of utilizing the materials of nature for the benefit of mankind." The second thought is of equal significance: "and the art of organizing and directing human activities in connection therewith."

With the control of force, and the utilization of material, is combined the conscious direction of the intelligence that transforms and applies the resources of nature. What a magnificent breadth of the field of engineering activity!

It has been pointed out frequently that the existing subdivisions of engineering are arbitrary and have no scientific differentiation. The civil, mechanical, electrical, mining, and the other divisions are all based on the same sciences—mathematics, physics, and chemistry—differently applied. All of them deal with natural phenomena, with physical force and inanimate matter. In contrast, the conscious organizing and directing of human intelligence must be based on the economic and social sciences of which our knowledge at present is incomplete, but of which we shall know more as we accumulate experience.

So we now recognize two great fundamental branches of the profession of engineering—the one is technical or technological; the other is managerial. Each is an applied science. Each is engineering.

To define them, drawing upon the phraseology of the constitution of The Federated American Engineering Societies:

Technical or technological engineering is the science of controlling the forces and utilizing the materials of nature for the benefit of mankind.

Managerial engineering is the science of organizing and directing human effort exerted to control the forces and to utilize the material of nature for the benefit of mankind.

The accepted recognition of managerial engineering as a fundamental branch of the profession, although it has always been a part of engineering activity, gives promise of securing better results with those problems in human affairs requiring for their solution technical judgment and engineering experience.

The First Step

IT is doubtful if any other engineering statement has received such widespread publicity and editorial comment in the daily press as the summary of the report of the Committee on Elimination of Waste recently submitted to the American Engineering Council. The widespread interest is perhaps more remarkable when it is realized that the report as a whole has not been released. The publicity has been given on a brief outline of the report as presented in a news summary. The claim of the engineers to a voice in public affairs has been at once granted by those who direct the great channels of information and news.

Although the report has not been issued, a few major facts are already public property.

The report places no blame upon any individual, group, or class. It reveals tremendous wastes, to be sure, but takes the position that in the past these have been, to a great extent, unavoidable; that in general, industry has been operated well. Were this not true, we would lack the tremendous structure of production that this country possesses; our standard of living would be much lower than it is today, and we would be unable to secure and enjoy many of our comforts and luxuries.

Instead of placing blame, the report seeks to fix responsibility for improvement. It does this by establishing a known level of possible performance set in a few plants where the effectiveness of operation is higher than the average. The work of the average plant is then evaluated in contrast with the higher possible level, and the loss in the zone between these two levels is assayed as waste.

One point, surprising perhaps to the general reader but not surprising to the engineer of experience, is that the greater responsibility is placed upon management and the lesser upon labor.

Another striking point which is brought out by inference at least, is the lack of durability of product and of method prevailing in American industry.

These emphasize a characteristically American point of view in regard to natural and human resources which may be one of the deep-rooted reasons for the losses and wastage revealed in this report. As a nation we are often charged with prodigality, and the supporting facts are so complete and comprehensive that little defence can be made.

A starting point for improvement in this direction is to emphasize anew the necessity of adopting methods and turning out products possessing quality and durability. The premature exhaustion of some natural resource has too often compelled a change of method and practice in American industry. Many another important natural resource is rapidly disappearing, our forests, our deposits of petroleum, our beds of anthracite coal, our stores of natural gas. It is frequently said that American people are the most stylish in dress of any, but this is secured at a great loss in durability. Conservation of resource, stabilization of method, and reasonable permanence in design will increase the usefulness of all that is produced and consumed.

The report is a presentation of fact determined by assays. Recently published statistics from the census of 1920 showed that in the year 1919 there were in the United States 288,376 industrial establishments. It is clearly impossible to make a comprehensive study of a nation-wide institution comprising nearly three hundred thousand concerns ranging in size from those employing many thousands of workers to others employing but a few. Neither time nor funds could be made available for any such investigation. The only practical method of evaluating the waste in American industry was to make a series of assays of what might be called the "lump of waste." This was the plan adopted.

At the outset a few industries were selected as representative of the major types prevailing throughout American industry as a whole. A selection was then made of representative plants in each of these industries. Each plant was studied in detail under the guidance of a carefully prepared questionnaire, presenting 58 main topics and 260 leading questions. These classify into: In general 12 main topics; on organization, 21 main topics and 92 leading questions; on technical matters, 7 main topics and 44 leading questions; on utilization, 18 main topics and 122 leading questions. The facts and information secured in the answers to these questions were assembled on an evaluation sheet. This method was followed uniformly for each plant and for each industry.

Such a course is in keeping with the attitude of engineers, which is to secure facts upon which decisions and action can be based. In this regard the report when it will be finally issued should be considered as a first step. It will lead to an understanding on the part of the public as well as industry itself of the tremendous losses and wastes in the operation of industry which can be eliminated by applying knowledge which is already possessed. Still further, it will indicate other investigation and studies which should be pursued to enlarge our body of essential facts in regard to the operation of industry, and thus secure the basis for still further and more extensive improvement.

Of particular interest to engineers is the astonishing fact that no accepted units of measurement exist for the performance or effectiveness of operation of industry. It is clearly the duty of the engineering profession to take immediate steps to develop these means for quantitative evaluation. Possibly no single determination will have a wider influence. Once it is possible to compare industrial performance accurately and quantitatively, rapid progress can be made in improving those conditions and practices which are proved to be below a reasonable attainment.

The first major investigation, on the part of a committee appointed by Herbert Hoover as president of the American Engineering Council, has been ambitious in its planning and purpose. Its effect will be comparatively insignificant unless further steps are taken at once to put its suggestions into effect, and unless action follows to bring permanent improvement.

BOOK REVIEWS

Municipal engineering 628

INDUSTRIAL HOUSING

By Morris Knowles

Publishers, McGraw-Hill Book Company, New York

REVIEWED BY LESLIE H. ALLEN
Fred T. Ley and Company, Inc.

THE author, drawing on his experience as engineer to the Housing Division of the Shipping Board during the war, gives in this book an excellent outline of the problems of town planning, and the engineering of sewerage and water supply, and other public utilities. More than half of the book is given over to engineering subjects. The opportunity to design a complete town comes rarely, but to the architect, engineer, developer of real estate, factory owner, or city planning board, who wishes to study elementary municipal engineering, this book will be exceedingly valuable, as the author has brought together in a small compass a large amount of useful information on the fundamentals of town planning and the laying out of utilities.

On the other hand, the treatment of housing is very inadequate, and the title "Industrial Housing" is misleading. The student of industrial housing problems generally concentrates his attention on the social and technical problems involved in the planning, building and management of the workman's house. To these topics, however, only a very small part of the present book is devoted. The plans of the houses given are not well designed, they are more expensive than most workingmen can afford, and no new thought or help is given on the difficult problem of housing the American workman in a good home that he can afford.

Mr. Knowles says, "If standards are suggested that will fully realize ideals as to what the home should offer, the cost would be so high that even a modest profit on the money invested would make the rental beyond what the wage earner can afford to pay. Whereas, if the standard be determined by the rental within the reach of the working man, then the conveniences and the accommodations offered will be below what would be considered adequate, and we will have failed to meet the problem." This is the unsolved problem of industrial housing, and the author does not lead us any nearer to a settlement of it.

Housing students must recognize that the subject of "ideals" is the confusing element. Is the workman to decide for himself according to his ability to pay, or are others to decide for him according to their ideals of what he ought to have? If the latter, who is to pay the difference?

The author is far more at home on subjects like Water Supply, Sewage Disposal, etc., on which he is a recognized expert. The chapters on these and other engineering topics are well written. Though not exhaustive they give sufficient data for the student to gain a fair working knowledge of the subject.

There is an excellent chapter on Town Planning, with several illustrations of interesting suburban developments. The American city has suffered much from a disregard of the principles of town planning. The work of the Government Housing Agencies during the war has set us new standards. These are well explained and illustrated here.

Mr. Knowles believes that employers should not own or manage their employees' houses, and in a chapter on Town Management the arguments supporting his position are well put.

There is nothing new in the subject matter of this book, or its presentation. Its value lies in that it is a ready reference book on elementary municipal engineering and town planning. An incomplete bibliography and an excellent index complete the book.

Operation studies 658.54

THE HUMAN MOTOR

By Jules Amar

Publisher, E. P. Dutton and Company, New York

REVIEWED BY A. L. DE LEEUW
Consulting Engineer

IN "The Human Motor" the author makes a conscientious attempt to cover the subject from beginning to end. Viewed from the standpoint of the pretentious title, "The Scientific Foundations of Labor and Industry," the book is disappointing. There is a great deal of information and interesting reading in this volume, but it cannot be called the foundations for labor and industry; it is, at the best, only a single stone.

The first three chapters are given over to statics and kinetics, dynamics and energetics, resistance of materials, elasticity, and machines. It is the opinion of the writer that all of this might have been left out, for it is neither complete nor clear enough to give a sufficient knowledge of mechanics to the man who has not studied the subject before, while to the man who has, it is quite superfluous. The author believes that these chapters are necessary, because later in the book he mentions mechanical laws and terms and formulæ in his study of the human motor, but there is no more reason to give a short handbook on mechanics than to include a textbook on mathematics.

If this book is intended for the engineer, which seems to be the case, the chapters on mechanics should have been omitted, and the following chapters dealing with anatomy and the description of the construction of the human frame should have been treated more fully.

The author makes a thorough study of the mechanical functioning of the human body, its intake and expenditure of energy under a great many varying conditions of laboratory tests. Food values, thermal values of

clothing, effect of atmospheric conditions—temperature, moisture, etc.—are studied comprehensively, and a great many authorities are given, besides description of tests, instruments, and the like. In these particulars the book is exhaustive and highly interesting; but the author's very effort of endeavoring to make it as complete as possible has led to what I consider its weakness.

From the title it appears that Jules Amar intended to make the knowledge of the action of the human body a basis for scientific considerations of the elements of labor, and the last chapters in the book are, to a certain extent, devoted to this object. They include studies of walking on the level, on inclined planes and stairways, of running and jumping, hauling of ropes, use of the hammer and file, and several other operations. These studies confine themselves entirely to the amount of energy expended on the different operations under varying conditions, and are certainly very interesting; but they cannot be called, by the widest stretch of imagination, the scientific foundations of labor and industry.

There is no doubt whatever that many operations in industry can be simplified and speeded up and the accompanying fatigue diminished by proper study of their elements. These results have been accomplished with some operations and they can be accomplished with many more; but the most enthusiastic devotee of this new art will hardly claim that nothing else but a thorough motion study is required to make a good landscape painter. We recognize instinctively that the painter has certain qualifications which cannot be expressed in terms of muscular movement. We realize that two persons may have equally keen eyes and steady hands, and yet the one can draw correctly almost without instruction and the other can never learn to do it. A similar difference exists between individuals in almost any kind of work, and the elements which cause this difference are so many and so elusive that a complete analysis must always be very difficult, if not impossible. It is this very analysis which M. Amar seems to have started to attempt. I say "started to attempt," because the attempt seems to have been given up as soon as the general broad knowledge of elementary functions of the human body was to be applied to conditions of labor and industry.

One of the reasons why it is extremely difficult to make laboratory tests in regard to labor conditions is that one must necessarily select for a subject of the test some individual with a fair amount of intelligence; somebody who can understand the instructions given him and who has at the same time sufficient strength of character and self-control to submit to the disagreeable conditions accompanying such a test. On the other hand, one of the limiting elements of labor is the nervousness, the state of fretting, which goes with disagreeable working conditions and which lowers the capacity of the workman probably more than actual fatigue. There may be a certain position of the feet which allows the workman to file with the minimum expenditure of mechanical effort, but the fact that he would have to maintain this position throughout the working day would fatigue him more than if he assumed various less favorable positions; and this is so, merely because the human being wants variety, and because, above all, he does not want to be constrained. To find how work can be accomplished with a minimum of fatigue and a maximum of result, work and workman must be studied under actual conditions. Even then it will be very dangerous to try to deduce general laws, unless an enormous number of observations have been made with different individuals for subjects.

It is especially for this reason that I believe the book to be very close to a complete failure considered as a scientific foundation of labor and industry, and yet very successful as a description of the human motor viewed from a purely mechanical standpoint.

Labor maintenance in industry. Management 658.4

LABOR MAINTENANCE

By Daniel Bloomfield

Publishers, The Ronald Press Company, New York

REVIEWED BY E. H. FISH

Consulting Engineer, Cooley and Marvin Company

MANY well-known firms have attacked the problem which is so concisely stated in the title of this book, that of maintaining a working force, but that they have attacked it in such varied ways, and with so little apparent study of the fundamental causes underlying labor unrest was never so manifest until this book was presented to the public.

In the present work, reports, all too brief, are made of the various plans for retaining a working force, which something over 200 different employers have experimented with, ranging from plain, and mostly discredited, welfare work to the case of employees practically buying out the original stockholders and running the business themselves.

Anyone looking for a precedent should be able to find something in the present book to support his contentions, no matter what they may be, so long as they have to do with employment work. The employment manager who wishes to widen the scope of his work, the general manager who wishes to put certain changes before his board of directors, the works manager who thinks that employment work is overdone, these can all find support for their beliefs here, for the book is a truthful statement of the things which others are actually doing.

The author opens with a general review of "service work" for employees, stating the views of many people as to its wide scope, discussing the relations which should exist between the service department and other departments, and reporting the place which such work is found to occupy in organization charts of many firms.

He then takes up in detail the organization of the department itself, sets forth the type of man who should be selected for its head and for subordinate positions, and discusses the pros and cons of "follow-

up" work for employees inside and outside the factory.

The next chapter deals with the subject of building up morale, which follows the lines lately grouped together under the head of "Non-financial Rewards." Two chapters are devoted to training systems, which appear to be as varied in scope and aim as the number of firms offering them.

The subject which receives the most attention of all is the timely one of Americanization, to which is joined a study of the health of the worker, apparently for the old reason that a sane mind in a healthy body is the most desirable of advantages. And this study of the worker's health, the author holds, must come before other co-operative work with and for the workmen can be undertaken. Accident prevention is given rather limited attention, considering the work which has been done in this field, but the reports deal entirely with the desirability of accident prevention, and do not attempt to discuss the safety devices by which it is achieved.

The question method of wage payment receives practically no attention, and the housing problem is also handled rather briefly. Financial aids—such as group insurance and profit-sharing—receive, on the other hand, considerable discussion. The fact that so few of the firms reported have got their systems under way, and that there are so few that have carried a strictly profit-sharing plan for any length of time, is not the fault of the author; he has faithfully reported what he has found.

All in all there is likely to be a shade of disappointment in the mind of the average reader, because the underlying reasons which have led these different firms in such different ways are not discussed to any great extent. It may be that it would be impossible to bring order out of the chaos, and it may be that holding up this chaos to the view of the public is a good method of showing the unsystematic way in which one of the most important problems of the day has been approached.

Employment management *658.4*

STANDARD PRACTICE IN PERSONNEL WORK

By Eugene J. Benge

Publishers, The H. W. Wilson Company, New York

REVIEWED BY M. M. JONES

Formerly Director of Personnel, The Edison Interests

STANDARD Practice in Personnel Work is a worthwhile addition to management literature, and should be especially helpful to those just beginning to explore the field of personnel administration. It might be considered as establishing a horizon line toward which one might travel. Many "meaty" suggestions, not only for the personnel manager and his assistants but for the general manager behind a personnel program, are contained in its pages.

One must assume that the author presents the book as his own view of standard practice in personnel work not so much from the standpoint of what is actually in effect now but more as a collection of the best practices in many places which he thinks may well be accepted as "standard." The title of the book, however, may cause misunderstanding, for the volume does not present a manual of standard practice, and hence it does not represent "standard practice" as management uses the term. Neither are the practices described in the book standard in the sense that all are in general use, nor are they even standard in the sense that all are generally accepted by men in personnel work as profitable and supported by accumulated experience.

Nevertheless, the author has brought together much material that will be of help to personnel men. "Items in a Typical Personnel Audit," "Items Possibly Included in a Personal Specification," "Scale for Grading Homes of Workers," "Reasons for Labor Turnover and Suggested Remedies," and many of the forms shown are both stimulating and helpful.

The author compresses much information into his fifteen chapters and covers many subjects in a distinctive and thought-provoking way. Among them are:

The Personnel Audit
Job Analysis
Study of the Community
Labor Turnover and Labor Loss
Organizing the Personnel Department
The Employment Process
Selection by Mental and Skill Tests
Method of Rating Ability
Education and Training
Health Supervision
Maintenance of the Working Force
Incentives and Wages
Employee Representation
Record Keeping in the Personnel Department
Personnel Research

His chart which apportions responsibilities among staff men under the personnel manager once more reminds us of the lack of definitions or a terminology having the weight of general use and acceptance. He places an "employment director," a "training director," etc., under a "manager," and thus runs counter to certain deep-seated traditions.

The after-effect of reading the book is one of strong apprehension. To contemplate the mass of system and red tape which industry must struggle with in order to handle properly the administration of personnel work is disquieting. When we add to this the mass of system existing in other management functions we may well wonder if industry can stand the cost of so much overhead. At any rate it increases the present receiver's already great respect for decentralization and the opportunity of the small unit. We may well concern ourselves with "taking apart" each large business and discovering the "ideal unit," so far as the factors entering into such a decision may be balanced. The author has rendered a real service in presenting a book which in addition to other helpful features serves as one more warning against drifting too far in the direction of centralization.

Not many businesses are large enough to organize so extensively as possibly they might organize if all the

methods presented by the author were made effective. It may be well for us to consider that, despite the attention large organizations secure, more than 80 per cent of the industries in the United States individually employ less than 500 people.

It is a source of regret that the book does not deal with what is now perhaps the most important phase of personnel work—the cost. The same attention to this phase of the subject as that given to others in the book would have greatly increased the value of the work. A classification of personnel accounts, a specimen budget, and a sample specimen financial statement would have been especially helpful at this time.

The long sentences, long paragraphs, and lack of subheadings make the book rather hard to read, so that a commuter or traveler with but short intervals of time to read will have trouble in getting what he should from the book. Moreover, it has somewhat of an academic tone, causing the reader to think that the author's views on matters of underlying policy, particularly in certain fields of recent controversy, arise more from an educational environment than from the atmosphere of actual management and ownership which has so much at stake. Despite these objections, however, the book on the whole is well worth while. It is suggestive and refreshing, and few men in management positions will read it without considerable profit.

Industrial education *6(07)*

TRAINING INDUSTRIAL WORKERS

By Roy Willmarth Kelly
Publishers, The Ronald Press Company, New York

REVIEWED BY CHARLES W. CLARK
Director, Schenectady Continuation School

MR. KELLY has done a signal service to the worker, to the educator, to industry, and to society, in this excellent book on "the new emphasis in education." He has interpreted the problem which is now facing society in a way that points constructively to a solution. In the first place, he has shown the educator clearly what is the duty of the government in its educational policies to meet the present-day vital needs of industry.

Again, he has shown industry what it must do to bring about what is so ardently hoped for, a more intelligent and capable body of labor, thus "helping industry to help itself". He has made it clear that the right of the working man, in common with the college man, lies in true freedom in the choice of an occupation and adequate training for it. At the same time he warns of the necessity of going beyond the attainment of mere increased earning power and of fitting every worker for a "larger life".

The limits of effective scientific management were reached when it was discovered that the quality of materials and the program of production were entirely at the mercy of untrained operators. We have tried apprenticeship courses and found they were not the solution of the problem. We have tried the vestibule training school and the foreman training classes, and found we were building on the sands. In our gropings we have discovered that the highly organized American school system is also groping; and Mr. Kelly has pointed out to those who have vision, the way in which these two seekers after results can get together on the same plane and by co-operating begin to produce results. It is time we became interested in discovering why our schools still function on the basis of a former generation's requirements.

Mr. Kelly very logically begins with an account of the nature and variety of industrial occupations in the United States. He shows the great need of training as evidenced by the conditions of unemployment now prevalent, especially among the unskilled workers, and proceeds with a masterly outline of the progress of industrial education which is enlightening to any who would welcome a comprehensive and well-arranged summary of this subject. An important truth is expressed in the statement that industrial training is being administered by a variety of conflicting and overlapping agencies, a condition of affairs which shows the need for some unifying agency.

The chapter on "Developing the Possibilities of the Schools," clarifies for the reader much of the mystery surrounding various educational terms, such as prevocational, manual training, technical, and general or special-type schools. There is a great deal of meat here for educators who may be casting about for ways of making their schools function more efficiently.

The author next turns to industry proper and reviews in an exceedingly interesting way the history of industrial agencies which contribute to the occupational development of the worker. The growth of the science of industrial service work, the new type of apprenticeship, vestibule training, and the training of foremen and minor executives follow in order, and in each case constructive suggestions are submitted.

The chapters on "Vocational Guidance in School and Industry," and "Organizing for Transfer and Promotion," afford a glimpse into the close relation which should exist between the school and industry, and should be very helpful to teachers as well as thought-provoking for industrial executives sometimes disinclined to bother with ideas of transfer or promotion. Two chapters dealing with records and the rating of employees according to their progress are followed by a discussion of participation by the employee in the management of a business; the point being made that the ignorant employee is incapable of any understanding of the modern methods of industrial organization without further education.

In the last two chapters of his book Mr. Kelly presents a program of education that offers a solution for the existing state of industrial inefficiency. It is a program with which every forward-looking leader of American life should be familiar. A few excerpts will reveal its worth:

> Here, then, are fundamentals which should underlie all forms of industrial education. Of primary interest is the wide-spread

dissemination of general educational opportunities through continuation schools, part-time schools, and the extension of the compulsory age limit. We must make it impossible for radical and ignorant persons to continue their hold upon the working classes. Better vocational guidance and improved methods of personnel management which will eliminate the unhappiness of those in misfit occupations and release workers from the fear of unemployment and unjust discharge, better adaptation of working conditions to the physical and mental constitution of the employee, are all matters of public as well as private concern. We ought to assist persons of ability who appear among families in straitened circumstances to acquire the elements of a general education and to take their first steps in becoming economically independent. If the vestibule school, the apprentice school, or the trade school enables the poor boy or girl to make "the start in life," the part-time school, the free state-supported high school and college, and a variety of educational opportunities maintained at public expense or by private corporations should open the way for continued advancement toward a more noteworthy achievement.

* * * * * *

The training of employment managers and of teachers for industrial classes should be regarded as a governmental function of utmost importance.

* * * * * *

National authority ought to be vested in a member of the president's cabinet, with such divisions or bureaus in his department as are required to administer federal aid for the states, conduct surveys, engage in research, and publish reports.

* * * * * *

The place of the public high school in training industrial workers should be greatly enlarged.

* * * * * *

Continuation education, not less than six hours each week, should be provided for those under eighteen years of age. There should be a minimum requirement of civics, physical culture, English and history. Beyond this, the work should be determined solely by the occupational and social needs of the student.

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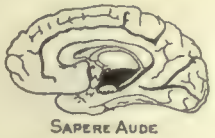

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THE JOURNAL OF PRODUCTION

VOLUME 1 AUGUST, 1921 NUMBER 2

Mechanical handling of materials in industry 658:621.8

The Moving of Materials in Industry

Nothing is Where We Want It, So Materials Must Therefore Be Moved as Well as Manufactured

By R. M. GATES

District Manager, The Lakewood Engineering Company

DURING the past few years there have been developed by ingenuous members of the engineering profession large numbers of mechanical devices for accomplishing the task of moving materials in industry, and although we are still inventing devices to help men move things in greater volume and at less cost than ever before, we are now coming to a more important phase of this development, namely, the greater application of devices already perfected.

That such a development is both logical and important is made clear when we consider that approximately 3 billion tons of material are originated every year in the United States. Furthermore, it has been estimated that each ton is handled on an average of 25 times, so that we are thus actually required to handle annually the huge total of 75 billion tons. If we consider that 10 million men who work on farms spend one-sixth of their time and that 7½ million wage-earners in industry spend all of their time moving some of this tonnage we thus have approximately 22 billion man-hours consumed each year in the handling of materials alone. Furthermore, since one man can move but 2 or 3 tons per hour as an average for all commodities, there is not enough manpower to do all of the work required.

Few persons realize, however, how many times products are handled. Take, for example, such a common commodity as bituminous coal, which is:

1. Broken down by hand.
2. Loaded into a car.
3. The car is hauled to the tipple.
4. It is next dumped into the railroad car.
5. The car is then switched out to the main track.
6. Hauled to the consumer's town.
7. Switched to the consumer's siding.
8. The coal is dumped on the floor or in a bin.
9. It is drawn off into stokers.
10. Ashes are shoveled to car or wheelbarrow.
11. Hauled to dump.

Recently a manufacturer stated that he was compelled to handle 168 tons of material in order to produce one ton of product, and many observers have stated that the average product is handled several dozens of times. It is, therefore, evident that our industrial and commercial welfare is absolutely dependent upon mechanical devices for the "picking up and putting down" of commodities.

This question of moving material is thus a major one in this country, for the United States is the greatest producer in the world. With but 6 per cent of the world's population and 7 per cent of the world's land, we produce:

	Per Cent
Iron and Steel	40
Lead	40
Silver	40
Zinc	50
Coal	52
Aluminum	60
Copper	60
Cotton	60
Oil	66
Corn	75
Automobiles	85

To handle such a large proportion of the world's productions thus necessarily requires that enormous amount of material be moved and, in the accomplishment of this work, modern material handling devices have come to be indispensable. A few years ago our iron ore from Lake Superior was handled by men with wheelbarrows over treacherous scaffolding and with much confusion, as is evidenced by Fig. 1. Today, however, we have two famous developments of mechanical devices for the handling of iron ore. These machines, shown in Figs. 2 and 3, will handle 700 to

1,000 tons of ore per hour, lifting the material out of a vessel's hold and placing it in cars or on a dock.

Similar devices also find application in other fields. Can you imagine, for instance, how many men with hand shovels it would take to remove 6,000 yards of earth, carry it up 20 to 25 ft. a distance of 70 to 80 ft. and put it into a railroad car? With 21 lb. shovels, this would mean approximately 900,000 shovelsful, to say nothing of the distance. We cannot measure this work in our imagination. Today, however, we have a machine operated by a mere handful of men which is capable of such a task. It is the steam shovel illustrated in Fig. 4. Machines of this type are among the giants of power that are doing our work and at 5 to 10 per cent of the former cost with hand labor.

Courtesy The Brown Hoisting Machine Co.

FIG. 1 THE OLD METHOD OF UNLOADING IRON ORE BY HAND

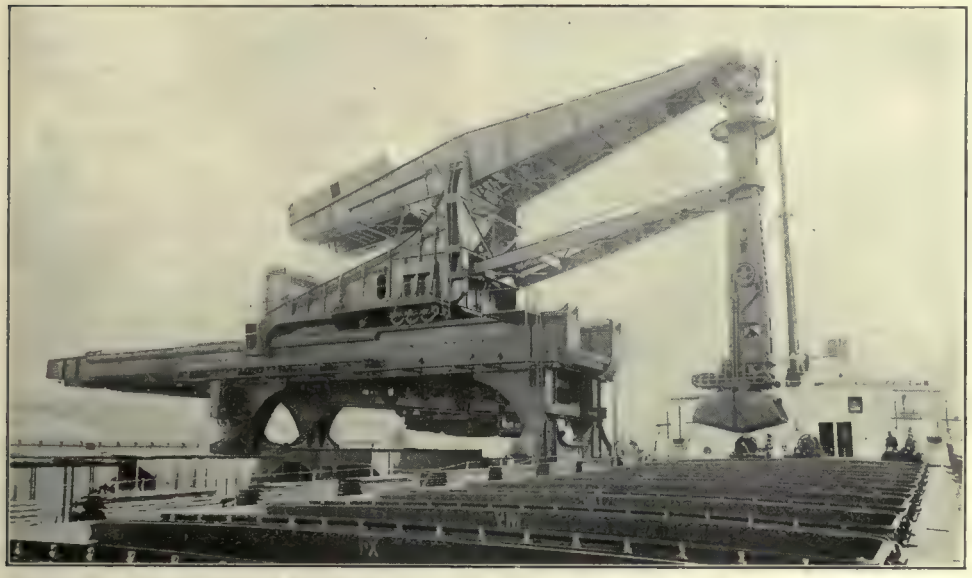
The ore was first shoveled into wheelbarrows, these were then hoisted to the ship's deck by means of a horse or windlasses, and finally men wheeled them over gang planks to the dock.

There are likewise smaller applications that are continually replacing human effort. Compare, if you will, the work of the hand laborer with the two-wheel truck, a familiar sight in the South, with the work done by the storage battery tractor and trailer. (See Fig. 5.) In the latter case the work is made more attractive for the men, and in this particular illustration the machine supplants 25 men and saves 162 man-hours a day.

But the handling of material is more than merely "picking up and putting down"; it is the very foundation of our industrial life and upon its successful development rests the powers of individuals, groups, and nations. We ship our cotton to New England to be made into cloth and then we reship it to the South to be worn. Hides are sent from the West to the East to be made into shoes and these are then sent West again for the market. Steel is shipped from Pittsburgh to Cleveland to be made into cranes and the cranes are shipped back again to help make more steel. A ceaseless army of men is thus continually employed in moving things and with the ever-increasing improvement of labor conditions and pressing needs of greater production, competition and the desire to do things that individuals and groups could not do, we are constantly being forced to develop machines that will do the work more easily and at a reduced cost. In other words our future industrial success depends in very large measure upon the use of mechanical material handling devices.

But while replacing men with machines develops civilization and we have wonderful inventions of machines to carry burdens, and to do the task which previously required human labor, the intelligent application of these machines is lamentably scarce. Does the average executive in industry, for instance, ever stop to consider that the multitudinous operations of handling materials are monotonous, laborious, and tedious and that

such operations have a tendency to deaden the intellect? Does he ever consider that the human mind is least receptive when the physical body is exhausted after a hard day before the furnace or forge and, greatest of all, does he ever consider that any human being who spends 10 hr. a days in such occupation will grow inactive and that most organizations are successes or failures depending upon the activity of the minds within the organization, whether it be that of the president or the yard laborer?



Courtesy The Brown Hoisting Machine Co.

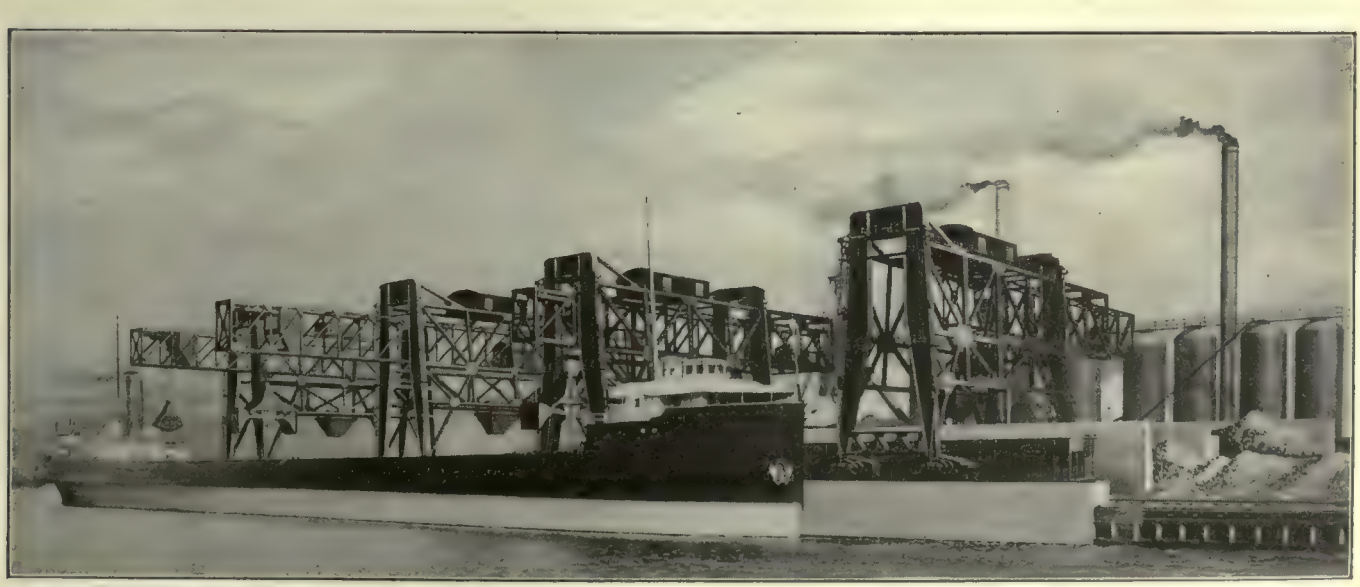
FIG. 2 A MODERN ELECTRICALLY OPERATED ORE UNLOADER

This shows a 15-ton machine, capable of handling 700 tons of ore per hour, unloading it direct from the vessel to railroad cars.

The handling of materials in industry is also not without certain economic phases, for if the tedious operations of industry can be encouraged in the use of methods and devices to increase production they can be recompensed directly for it and their demands on society will in turn increase. These in turn will react upon the demands for their product, for as our economists have told us want makes man work, work gives him wealth, and wealth in turn makes him want more, and then the cycle repeats itself.

But more than an economic advantage will be gained, for by relieving the human body of laborious tasks the industrial worker may grasp the problems in economics, the lessons in language, the work in the trades, and the ideals of American citizenship. In short, civilization itself will be advanced.

In the accomplishment of such aims the first consideration should look toward the complete utilization of the forces, methods, and machines available for the handling of material in industry. Many establishments are now being built on this basis, but there are unfortunately too many that have been established on unsound principles. It is not unusual for a corporation to buy a piece of property, build a structure to fit, buy certain machines which have normal rating capacity and then begin to consider in detail from subject to subject and from department to department just how and where the product will be handled, stored, assembled, and packed. The woeful number of such plants, particularly in the eastern part of the United States, is so large that the effect of this type of management makes one feel that those who have survived have made a profit in spite



Courtesy The Wellman-Seaver-Morgan Co.

FIG. 3 ORE UNLOADERS WHICH UNLOAD AND DISTRIBUTE TO STORAGE PILES.

of themselves. In other words these older plants and a large percentage of the newer ones were built with no idea of facilities for expansion, but with the single

Courtesy The Marion Steam Shovel Company

FIG. 4 ONE OF THE LARGEST STEAM SHOVELS BUILT

thought that they would take care of any and all increase in business.

In such endeavors, those who crystallized their plans failed to co-ordinate the physical conditions with the forces of capital and labor and to so apply them to the product as to satisfy the demands of civilization to the highest degree. The true application of these principles is the best measure of engineering executive ability, and the future success of American business depends to a considerable extent upon the practical application of such knowledge. Today we are the undisputed leaders of production. Tomorrow we must be more. We must also excel in a quality of design, in quality of material, in quality of workmanship, and, most important of all, goods must be produced at lower costs.

This problem of cost reduction is vital to American industry, and in its accomplishment thousands of machines with literally millions of combinations may be used. Furthermore the efficiency of every machine will depend upon its relation with others, the physical surroundings, and the personal equation of the operator. The field is unlimited, and the need is so pressing that we can well afford to give our best consideration to this exceedingly important problem of the mechanical handling of materials.

Many industries have already achieved much along these lines. The enormous production of the automobile, for example, has been made possible because of the labor-saving devices which have been used to assist the man at the assembly work. Fig. 6 illustrates one such labor-saving device commonly employed today. Another saving comes through the efficient use of storage space, and Fig. 7 illustrates a type of hoisting and conveying equipment especially adapted to congested areas. Still another item which goes to make up the cost of moving material is the checking of the quantities received and shipped, and today materials are invariably measured by weight. Fig. 8 shows how this is accomplished in one industry as the material passes along in its uninterrupted line of travel.

In still another instance modern methods of handling material resulted in the elimination of the necessity for a new building. This occurred in one of the leading automobile manufacturing plants where additional capacity was required to store dual-tread wheels. Approximately three times the storage space was needed, and it was found that by the use of a storage battery elevator truck and tiering machine, the wheels could be stored in the existing space, and that at the same time the cost

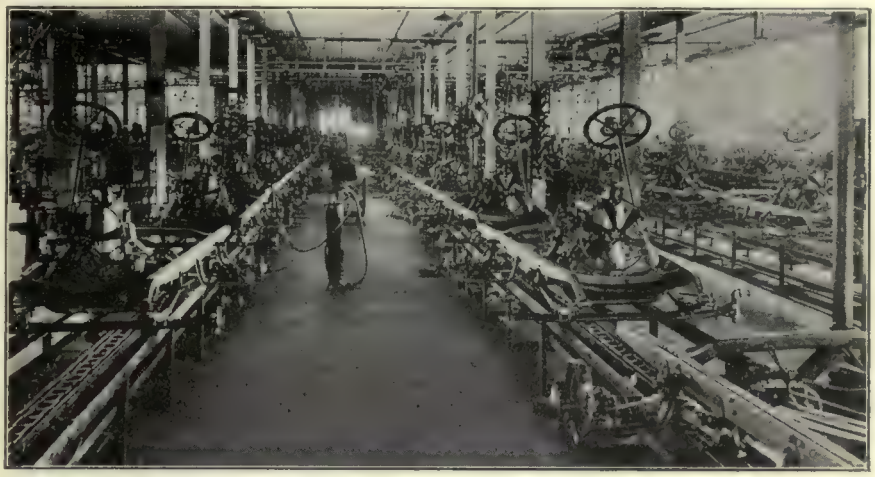
Courtesy The Lakewood Engineering Co.

FIG. 5 CONTRASTING METHODS OF HANDLING COTTON BALES

Above the time-honored combination of negro and hand-truck; below the modern tractor and trailer system.

of handling greatly reduced. Fig. 9 shows the machine used for this work.

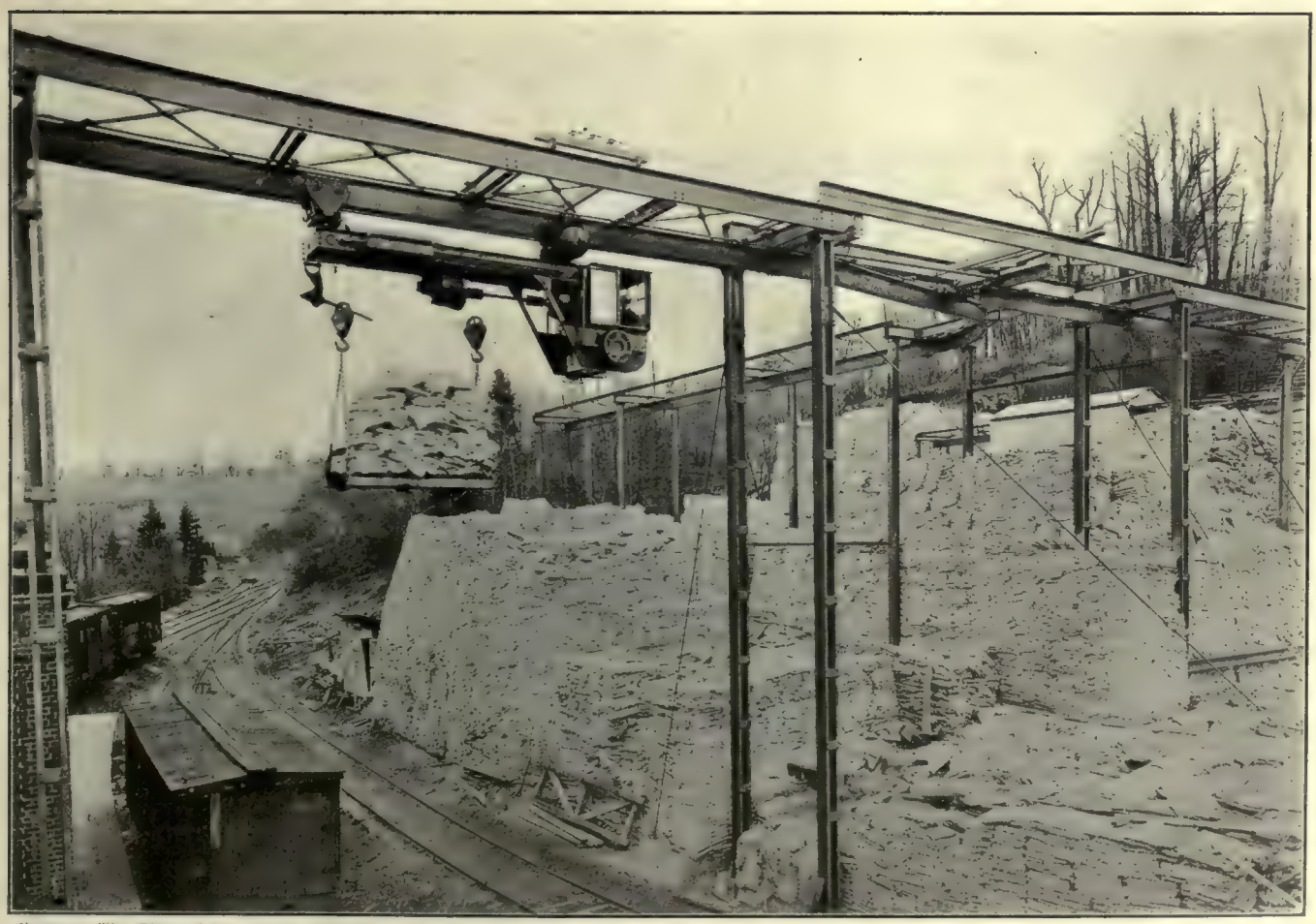
To increase production and reduce cost has thus been found to be dependent not only upon cheaper and better processes of manufacture, but upon cheaper and better ways of handling our materials as well. The cost of handling materials is not, however, an item easily determined, for while modern cost-keeping systems have reached a high state of development, yet in a majority of cases the accounting departments cannot tell how much it costs to handle materials, either by separate departments or for the entire plant. Such costs are absorbed in the general process of manufacture. And high unit prices often vary so much that it is frequently difficult to know exactly where to place the blame. Variations of plant unit production costs will be effected, however, more by handling charges than by machine charges, for machines have a definite speed and capacity while the human element is not as great a factor as when there are no machines and all the work is done by hand. If manufacturers would, therefore, be made to realize the enormous waste due to the lack of the proper consideration of their handling methods in costs there would be some radical changes in their methods.



Courtesy The Link-Belt Company

FIG. 6 A GROUP OF AUTOMOBILE ASSEMBLING CONVEYORS

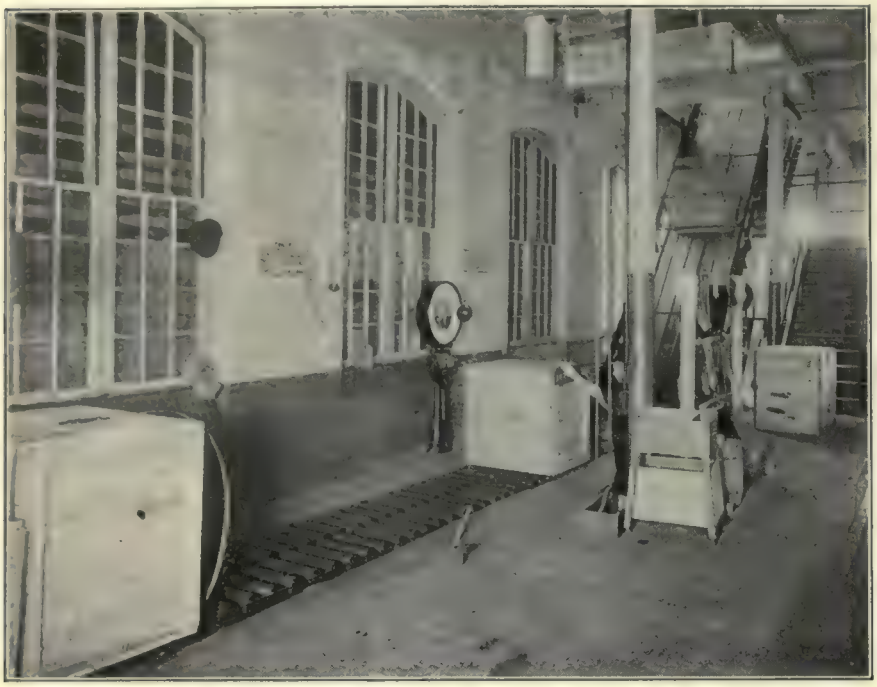
The way to accomplish this is to make available the cost of handling of materials by modifying present accounting systems so that the cost of process and the cost



Courtesy The Shepard Crane and Hoist Co.

FIG. 7 CONGESTED AREAS UTILIZED FOR STORAGE THROUGH THE USE OF HOISTING AND CONVEYING EQUIPMENT

of handling can each be easily obtained. Manufacturers who have been most successful with handling systems place what might be called a way bill on each shipment as it leaves the stores-room for the department of manufacture. Such a system has meant a revision of cost methods, but the company now knows how much it actually costs to move the parts from the time the material is received till the finished product is shipped.



Courtesy The Mathews Gravity Carrier Co.

FIG. 8 A CONVEYOR HANDLING GOODS IN CASES

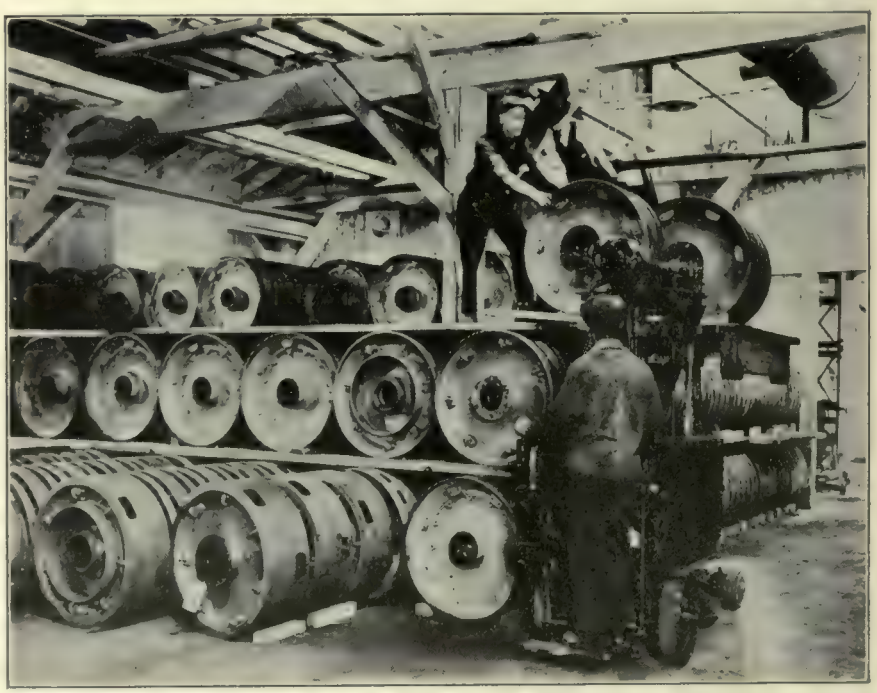
A feature of this installation is the dial scales which weighs the cases as they pass to and from the receiving and shipping department.

This subject of the cost of handling materials is so vital that it is worthy of special and intensive consideration. But while the processes of industry have had their specialists who have been most successful in developing their work to a science, no such intensive study has ever been made of that common branch of all industry—the handling of material.

To solve the problem we must, therefore, plan our heavy work so that the employee can be educated to use both his mind and his hands with greater economic advantage and thus obtain for himself the benefits that may be derived from his education, Practically every industry has departments of:

Purchasing—For buying.
Manufacturing—For fabricating.
Selling—For distribution.
Advertising—For establishing prestige.
Accounting—For analyzing cost and handling money.
Engineering—For design.

We also have specialists in all of these subjects. Courses at our universities are being developed to train men for them, and trade journals are devoted to their interests. Where, however, will we find a specialist or a department whose whole concern is the moving of material? It is true we have the tracing clerk of the purchasing department, the receiving and order clerk at the warehouse, the production manager in the factory, the manager of the welfare department, the routing clerk of the cost department, and the efficiency engineer of the engineering department. Each, however, is interested in but a partial movement of material. A few are responsible to a greater or less degree for some phase of the movement, and "everybody's business is nobody's business." A true production manager is greatly needed. He should be responsible for the movement of material from the time of receipt until it is shipped. He should be a master of the art of handling material, familiar with all types of mechanical appliances, their relations one to the other as applied to industry. He should also realize that the proper application of these machines is the basis of a greater and more profitable production.



Courtesy The Lakewood Engineering Co.

FIG. 9 SAVING FLOOR SPACE BY TIERING

The method of storing saving approximately two-thirds the floor space formerly required. Each wheel shown weighs about 500 lb.

The Elimination of Waste in Industry

An Abstract of the Summary Report of a Special Committee of American Engineering Council

The first investigation under the direction of the American Engineering Council was a study into the wastes and restrictions in industry. This was suggested by Herbert Hoover at the time of his inauguration as President of the American Engineering Council. A committee of eighteen engineers was appointed in January, 1921, and a summary of their report was presented to the Executive Board of the Council on June 3. The final report was approved and released for publication on July 15. It is a document of about 140,000 words, divided into three sections: the first, the summary report of the committee as a whole; the second, the reports of the engineers who made field investigations; the third, statistical reports giving a general background for the recommendations offered. As a general interest will center on the summary report this alone has been abstracted below. The matter omitted has been largely cumulative evidence and explanation. The eighteen engineers who form the committee are: J. Parke Channing, chairman; L. W. Wallace, vice-chairman; L. P. Alford, George D. Babcock, Wm. R. Basset, F. G. Coburn, Morris L. Cooke, Harrington Emerson, Ira N. Hollis, Herbert Hoover, Edward Eyre Hunt, C. E. Knoeppel, Robt. Linton, Fred J. Miller, H. V. R. Scheel, Sanford E. Thompson, John H. Williams, Robert B. Wolf.

IN making the studies upon which this report is based and in preparing the report itself there has been no purpose or desire to place blame upon any individual, group, or class. It is believed that the wastes revealed are the inevitable result of methods, tactics, practices, and relationships of long standing in industry, and the committee has merely desired to indicate the main opportunities for eliminating waste and to show whose opportunity or responsibility it may be to adopt proper measures for such elimination.

No attempt has been made to write an academic definition of waste or to speculate in regard to ultimate savings. For the purpose of this report no attempt has been made to consider all economic wastes. Rather, in the committee's investigations industrial waste has been thought of as that part of the material, time, and human effort expended in production represented by the difference between the average attainments on one hand and the performance actually attained on the other as revealed by the detailed reports. In assaying waste in industry the committee has undertaken to evaluate this difference. The limitations of the study are indicated in the following tabulation:

Branch of Industry	No. of Plants Investigated	No. of Plants Furnishing Additional Information
Building Industry	73	33
Men's Ready Made Clothing Manufacturing	9	..
Boot and Shoe Manufacturing	8	34
Printing	6	19
Metal Trades	16	17
Textile Manufacturing	13	..

Each engineer who made a field investigation was thoroughly acquainted with the industry he studied and the choice of the facts to be presented, and the deductions drawn from those facts were made by him on the basis of his expert knowledge and the composite experience and knowledge of the entire committee.

Plan of Study, Questionnaire, Evaluation Sheet

The plan of study followed in each of these six branches of industry was this:

At the outset the members of the committee prepared an analysis of those factors and operations in industry in which waste might be expected to be discovered, provided a comparison was made between average practice and the best known practice. From this analysis a trial questionnaire was prepared to secure information and quantitative data to permit of comparing the record of one plant with another. This trial questionnaire was then used in making a study of one plant in each industry. The results of these trial studies were then brought together, compared, reviewed by the committee and, as a result, a revised questionnaire and an evaluation sheet were prepared, to be used in making the final field studies.

The individual reports forming the third section of this complete report differ in character from the field studies, inasmuch as each is a survey of conditions generally, rather than a study of any one plant or branch of industry. They were compiled from existing information, and each is signed by the one responsible for it. They, therefore, support from a broader point of view many of the specific findings presented in the field reports, and thus give a more general background for many of the recommendations offered.

The Sources and Causes of Waste

Four Aspects of Waste in Industry. Waste in industry is attributable to:

1. *Low production,* caused by faulty management of materials, plant, equipment, and men.

2. *Interrupted production*, caused by idle men, idle materials, idle plants, idle equipment.
3. *Restricted production*, intentionally caused by owners, management, and labor.
4. *Lost production*, caused by ill health, physical defects, and industrial accident.

Responsibility of Management. Management [1] has the greatest opportunity and hence responsibility [2] for eliminating waste in industry. The opportunity and responsibility of labor is no less real though smaller in degree. The opportunity and responsibility chargeable to outside contacts cannot be so clearly differentiated or evaluated. The relative measure of these is shown by the quantities in the following table which come from the composite evaluation sheets in the engineers' field reports:

Industry	Responsibility Assayed Against			Totals
	Management	Labor	Outside Contacts[5]	
	Points[3]	Points[3]	Points[3]	Points[3]
Men's Clothing Mfg.	48.33	10.50	4.95	63.78
Building Industry[4]	34.30	11.30	7.40	53.00
Printing	18.00	16.25	23.36	57.61
Boot and Shoe Mfg	30.25	4.75	5.83	40.93
Metal Trades	23.23	2.55	2.88	28.66
Textile Mfg.	24.70	4.70	19.80	49.20

From the preceding table are derived percentage values for each of the agencies against which responsibility is assessed, as follows:

Industry	Responsibility Assayed Against		
	Management	Labor	Outside Contacts
	Per cent	Per cent	Per cent
Men's Clothing Mfg	75	16	9
Building Industry	65	21	14
Printing	63	28	9
Boot and Shoe Mfg.	73	11	16
Metal Trades	81	9	10
Textile Mfg	50	10	40

The quantities presented above justify the following statement: Over 50 per cent of the responsibility for these wastes can be placed at the door of management and less than 25 per cent at the door of labor, while the amount assayable against outside contacts is least of all.

[1] The term "management" as used in this part of the report refers to the agency (owners or managers) which exercises the management function in industry. This function is defined in a report approved by the Management Division of The American Society of Mechanical Engineers as:

"Management is the art and science of preparing, organizing, and directing human effort applied to control the forces, and to utilize the materials of nature for the benefit of man."

[2] The "responsibility" of a given agency as here used does not mean moral responsibility as ordinarily understood, but only that responsibility which arises from the undeniable fact that a given cause of waste can be removed only by a particular agency ....."We measure responsibility not by the thing done, but by the opportunities which people have had of knowing better or worse."

[3] The relative responsibilities have been evaluated in "points." A theoretical total of 100 points represents all possible waste. As no plant is, or could be, entirely wasteful, the number of points assigned in any case must be less than 100.

[4] Adjusted by field engineer to a basis comparable with the other field evaluations.

[5] By "outside contacts" is meant the public, trade relationship and other factors.

In every industry studied there are outstanding examples of good management but the bulk of the industry does not approximate this standard. In the clothing industry, for instance, one plant was rated by the engineers 57 points higher than the worst one studied and 42 points better than the average.

The following table gives a comparison for each industry studied of the total number of points assessed as waste in the best plant investigated, compared with the average of all the plants:

Industry	Points Assayed Against The Best Plant Studied	Points Assayed as The Average of All Plants Studied	Ratio: Best to Average
	Points	Points	
Men's Clothing Mfg.	26.73	63.78	1:2
Building Industry	30.15	53.00	1:1½
Printing	30.50	57.61	1:2
Boot and Shoe Mfg.	12.50	40.83	1:3
Metal Trades	6.00	28.66	1:4½
Textile Mfg.	28.00	49.20	1:2½

It must not be assumed that these points or ratios are valid in comparing the waste in one industry with that in another. They are useful only in making a comparison of waste in plants within the industry where they were assessed. Further, the quantities disclosed by the evaluation sheets are only a part of the findings dealt with in this report.

These tables present the consensus of opinion of the engineers engaged in field studies to the effect that the average of management is much below the standards set by certain individual executives who have achieved notable success.

Waste Caused by Low Production

Faulty Material Control. In certain industries the waste of materials is a serious drain on production, a fact which is revealed by a comparative study of plants in the same field. The methods of control which are common in the shoe industry account for the greatest loss in shoe production with the possible exception of seasonal demand and production. Firms leave it to the cutters to economize in leather. Where standards are in use, waste frequently occurs through carelessness and lack of training of cutters. The loss from idleness in shoemaking, occasioned chiefly by waiting for work and material, is estimated to be some 35 per cent of the time.

The average contractor has no calendar of operations except the dates of starting and finishing a job. He largely regulates deliveries of materials by visits to the job, or through statements received from the job superintendent. Haphazard methods of planning result in delays for want of material, or in burdening the job by an oversupply of material. The same practice results in frequent layoffs, causing dissatisfaction, the loss of good mechanics, and a high labor turnover. Still

another waste from inadequate material control comes from the speculative purchasing of raw materials. In the clothing industry gambling in cloth is common.

Faulty Design Control. The defective control of design results in a major waste, since it prevents standardization of product. In the building trade, for example, while the standardization of dwellings and other types of buildings is not generally practicable, yet certain details are entirely capable of standardization. Standardization of the thickness of certain walls might mean a saving of some $600 in the cost of the average house. Standardized millwork, such as window frames, doors, and other similar items, would reduce the cost.

In the printing trades there is wide variation in flat-bed cylinder presses; there are more than 600 types of folding machines. Formerly each type foundry cast its type on a more or less different body, and although the exchange from the old system to the point system involved an expenditure of some $3,000,000 by the type founders, it is universally conceded that this expenditure has been saved many times over. Such an example points the way to further efforts.

There are approximately 6,000 brands of paper; 50 per cent of which are more or less inactive. The duplication of brands serves no useful purpose and ties up money in unnecessary stock.

Faulty Production Control. The lack of adequate methods of production control is evident in every industry studied. It is one of the outstanding weaknesses. From shop records it is found that the average loss in clothing factories during running time, not including shutdowns, is between 30 and 35 per cent. If we call 80 per cent running time the maximum readily attainable, this means a possible increase of nearly 20 per cent in productive capacity, and a similar increase in plant capacity. Fixing the value of annual output in the men's ready-made clothing industry at $600,000,000 it should be relatively easy to save three-quarters of a million dollars a day, an increase of 40 per cent in effectiveness.

The lack of production control is not a question of large versus small plants. In the metal trades, for example, the engineer declares that the size of the plant does not necessarily determine its efficiency, for some of the large plants as well as some small ones show a large waste factor.

Lack of Cost Control. The majority of industrial plants lack a knowledge of costs and have no cost control. Therefore, there is no adequate method of judging fairly and accurately when improvements are needed and when waste is occurring. Not having the facts prevents prompt correction of defects. The above conditions are disclosed, for example, in the report on the metal trades.

Lack of Research. While certain industries are ahead of the rest in plant research, the need for more intensive research activity is apparent in every industry. One industry which is backward in this respect is clothing. In the majority of men's clothing plants nothing approximating research is practiced to improve materials, processes, equipment, or product.

Faulty Labor Control. With perhaps two or three exceptions, shoeshops have no departments maintaining modern personnel relations with the employees. The cost of training an inexperienced man for cutting upper leather in a well-managed shop is $576; for a semi-experienced man, $450; and to install an experienced man in a different shop costs $50. For the average shop these figures are unquestionably low.

The average labor turnover for the year 1920 in the metal trades plants covered (wherever records were kept, which was the case in less than half of the plants) was 160 per cent—figured in most cases as the ratio between the number of "separations" and the average number of employees on the pay-roll. The highest turnover was 366 per cent.

The building trades have given little consideration to the subject of labor turnover. In construction work it is particularly difficult to estimate the extent, because the actual percentage of turnover constantly varies as the building progresses and the number of men is increased and later decreased.

Ineffective Workmanship. Still another loss resulting in low production arises from inefficient workmanship. For much of this management is responsible through failure to provide opportunities for education or special training. Management cannot, however, do more than provide these facilities, and experience has shown that it is difficult to interest workmen in training courses which are designed to increase effectiveness. Further, much ineffective workmanship arises from lack of interest in work or lack of pride in good workmanship.

Faulty Sales Policies. The cancellation of orders is a condition peculiar to certain industries. It is especially acute in the clothing industry. Purchasers buying on long-time contracts return unsold goods at the end of the season, and claim and receive credit. In normal seasons cancellations have ranged from 3 to 14 per cent, and returns from 5 to 11 per cent in the average shop. In abnormal years, like 1920, cancellations have reached 33 per cent and returns 18 per cent.

WASTES CAUSED BY INTERRUPTED PRODUCTION

Idle Men. The amount of idleness or unemployment in industry can only be evaluated through rough estimates. There is no national machinery for collecting the facts. But in the best years, even the phenomenal years of 1917 and 1918 at the climax of war-time industrial activities, when plants were working to capacity and when unemployment reached its lowest point in 20 years, there was a margin of unemployment amounting to more than a million men. This margin is fairly permanent; seemingly one or more wage-earners out of every 40 are always out of work.

During periods of industrial and business depressions, unemployment reaches its highest peak. Such depressions appear more or less regularly at 7- or 10-year periods and each brings its increase in unemployment and wastage of the productive capacity of industry. In January, 1921, a nation-wide survey of employment made by the U. S. Employment Service of

the Department of Labor showed that there were 6,070,648 workers then employed in industry as compared with 9,402,000 in January of 1920, a decrease of 3,331,352 or approximately 35.5 per cent. This survey covered 35 states and 182 industrial cities and centers and may be considered as fairly reflecting conditions at that time.

In addition to minimum and climacteric unemployment, many essential industries show a high unemployment or idleness once a year or oftener. Practically all industries are in a sense seasonal. To present a few examples: The clothing worker is idle about 31 per cent of the year; the average shoemaker spends only 65 per cent of his time at work; the building trade workman is employed only about 190 days in the year or approximately 63 per cent of his time; the textile industry seemingly has regular intervals of slack time; during the past 30 years bituminous coal miners were idle an average of 93 possible working days per year.

Another form of unemployment comes from open conflict between management and labor. Here it should be said that in the past, at least, the amount of waste from the general run of strikes and lockouts through loss of wages and curtailment of production has been less than is popularly supposed. Since most strikes occur in seasonal employments, it can be deduced that output is not necessarily penalized, for it is often possible to make up the losses incurred by strikes through increased production at other times. The year 1912, with 47 per cent of the entire labor force out on strike and with an average loss per man of 40 days, showed an increased output of coal per man per day and per year, and six days' more employment than in 1911, which was relatively strikeless.

Idle Material. The waste of idle material through deterioration, obsolescence, and carrying charges is large, particularly where there are great inventories of both raw material and finished goods. Unbalanced production is another notable cause of idle materials and consequent waste. Examples of avoidable waste such as the following are fairly common:

A shoe factory having a capacity of 2,400 pairs of shoes a day could turn out for a considerable period only 1,900 pairs because of shortage of needed racks. Another factory had 50,000 pairs of shoes tied up in the fitting room instead of the normal 15,000 because of congestion of operations.

Idle Plants and Equipment. Unsound production policies result in wasteful overequipment. Clothing factories are built 45 per cent larger than is necessary; printing establishments are from 50 per cent to 150 per cent overequipped; the shoe industry has a capacity of 1,750,000 pairs of shoes a day, and produces little more than half that number; throughout the metal trades, standardization of products would permit of large reductions in plant and equipment.

Standardization of machine sizes would make possible the use of one machine for a greater variety of different jobs. The printing industry illustrates this point also. A common sight in any large printing establishment is expensive machines covered up and out of use, or inefficiently used for purposes other than that for which they were built. A printer secures a contract and buys a machine to do the work economically. When the work comes up for contract next time, if some other printer secures it, it invariably means another special machine. One concern paid $17,000 for a special press for printing a trading stamp. On losing this job, the press was scrapped, and later sold for $2,000. The contract in the meantime had been awarded to three other printers in succession and each in turn had purchased a new press which he had to scrap or later use disadvantageously.

It has not been possible in this assay to estimate the amount of idle equipment, nor the accompanying waste through maintenance and depreciation charges.

Waste Due to Restricted Production

Restrictions by Owners and Management. Some of the evils of restricted production are chargeable to owners and management. In the building trades, contractors, builders, and supply dealers have restricted production by maintaining high prices, collusion in bidding, and unfair practices. At times there has been collusion between employers and labor, tending to raise prices unduly. The waste from these causes has not been measured in this study.

Restrictions by Labor. Restrictions of individual output for which workers are responsible are susceptible of measurement. On the one hand, when workers are scarce the less conscientious workers become independent and slacken speed. On the other hand, the dread of unemployment is so pronounced that employees engaged in seasonal enterprises frequently restrict production to make employment last longer; some workers, moreover, through consideration of their fellow employees, limit production to provide work for them. Important restrictions of output by employees can only result from collective action. In the building trades, for instance, some painters' unions do not permit of the use of a brush wider than 4½ in. for oil paint, although for certain classes of work a wider brush is more economical. Plumbers' and steamfitters' unions prohibit the use of bicycles and vehicles of all sorts during working hours. Members of those unions in some sections of the country demand that all pipe up to 2 in. shall be cut and threaded on the job.

The tools of the engineer are standard weights and measures, scientifically established. Many unions now oppose the use of such standards. Practically all of the printing unions oppose these devices. The restriction of the number of apprentices is a common rule. The engineer in the building trade notes that restriction of apprentices in many cases seems extreme and unfair. All such restrictions, so far as they prohibit the use of the best and most efficient machines, constitute limitations of output. The actions of most unions, however, are confined to the restriction of the use of machinery rather than its prohibition.

The rule requiring that members of one craft union shall not encroach upon the work of another results in large waste and little benefits. Unions frequently require three or four skilled employees to perform vari-

ous operations on a plain job which a single worker could satisfactorily do by himself. Union carpenters are forbidden to lay bricks, union plumbers are forbidden to do carpentering work, and so forth.

A union rule in the newspaper printing industry requires that all advertising matter coming into the plant in electrotype form must be reset by the compositors. This useless work is sometimes done weeks after the advertisement has appeared.

The following instances further illustrate restriction of output through divisions of labor. Carpenters' helpers are prohibited from using carpenter tools, requiring carpenters to do such work as stripping forms from concrete. Experience shows that helpers can do this more economically and as well. Brick masons insist on washing down and pointing brick work when laborers could do it more economically.

WASTE DUE TO LOST PRODUCTION

Ill Health. A report on national vitality prepared in 1909 for the National Conservation Commission, appointed by President Roosevelt, estimated that there were then about 3,000,000 persons seriously ill at all times in the United States. This meant an average annual loss per person of 13 days owing to illness. It was estimated that 42 per cent of this illness was preventable, and that such prevention would extend the average life by over 15 years. Since that report was issued, an evident reduction in illness has been accomplished, so that today an estimate of between 8 and 9 days is probably nearer the fact.

In discussing public health conditions there is no clear distinction between the standing of the 42,000,000 persons classed as gainfully employed in the United States and those specifically engaged in industry. The 42,000,000 men and women gainfully employed probably lose on an average more than 8 days each annually from illness disabilities, including non-industrial accidents—a total of 350,000,000 days.

Defective Vision and Defective Teeth. Special attention has been given in recent years to the question of defective vision and to that of defective teeth. It is estimated that 25,000,000 workers have defective vision requiring corrections. A very large proportion of workers have defective teeth and mouth infection and workers have defective teeth, mouth infection and other physical defects which reduce their effectiveness.

Industrial Accidents. In 1919 there occurred in industry about 23,000 fatal accidents, about 575,000 non-fatal accidents causing four weeks or more of disability, and 3,000,000 accidents causing at least one day's disability. Figures for 1918 were about 13 per cent higher, and the estimated time lost 296,000,000 days.

RECOMMENDATIONS FOR WASTE ELIMINATION

In preparing this third part of the summary, the committee endeavored to interpret responsibility in terms of what might be done to eliminate waste in industry. The policies and methods recommended are such as are already in successful use in the industries and plants investigated.

RESPONSIBILITY OF MANAGEMENT

Organization and Executive Control. Planning and control should be adopted as fundamentals of good management. For the most part they have not as yet penetrated the mass of American industry.

Production Control. Conscious production control tends to reduce or eliminate waste by shortening the total time of production. It insures that material is delivered where needed, whether it be material in process or a finished product ready for shipment. Material schedules should be installed and used.

Balancing Productive Capacity and Demand. Productive capacity should be conservatively based upon a careful study of normal demand.

Development of Purchasing Schedules. There should be the same careful co-ordination of purchasing functions and control of material purchased and not yet received as is given to that already in the plant.

Elimination of Cancellations and Curtailment of Returns. The practice of cancellation of orders between manufacturer and mill, and between manufacturer and customer, should be eliminated, and there should be a curtailment of the privilege of returning goods ordered and received.

Correlation of Production Schedules with Sales Policies. Production schedules should be based on a carefully formulated sales policy determined from an intensive study of markets.

In many factories, losses of labor and material in spoiled and defective work are unwarrantedly high. The indirect losses, which are harder to detect and measure, are often greater than the direct losses.

Maintenance of Plant and Equipment. Plant and equipment must be maintained continually in working condition.

Uniform Cost Accounting. Generally accepted systems for finding costs should be established in each American industry. In controlling production and in judging fairly and accurately when and where progress and improvement are being made, the lack of a good cost control system is necessarily a source of waste.

Methods of Wage Payment. Methods of wage payment should be adopted, equitable and just in their basis, stimulating to effort on the part of the worker and insuring a proper relationship between effort put forth and results achieved by all who participate in the enterprise.

Standardization of Product. Products should be standardized consistent with progressive development of manufacturing.

Standardization of Materials. Materials should be standardized to the fewest practicable kinds, sizes, and grades.

Standardization of Equipment. At least the details of equipment, including machines and tools, should be standardized so as to permit of the widest interchangeability and maximum usefulness consistent with improvements in design and inventing.

Performance Standardization. Performance standards should be developed as a valuable aid to planning and production control.

Management and Workers. Management has a definite responsibility in selecting, upholding, and maintaining personnel.

Prevention of Accidents. Management has a definite responsibility to prevent industrial accidents. With regard to methods there is an abundance of information.

Research. Industrial research should be consistently carried on, both in the individual plant and by associations.

Responsibility of Labor

Increasing Production. In discharging its responsibility for eliminating waste in industry, labor should co-operate to increase production.

Standardization of Work. Labor should co-operate to prepare for and even demand the determination of and use of performance standards.

Rules Regarding Restrictions. Labor should change its rules regarding restriction of output, unreasonable jurisdictional classification and wasteful methods of work, thereby removing some sources of waste.

Improving Health and Reducing Accidents. Labor is responsible no less than management for improving the health of the workers and for preventing accidents.

Improving Industrial Relations. Inasmuch as the organization of personnel relationships in industry can only be accomplished through the co-operation of both employer and employee, labor should assist in such work of organization and in maintaining and utilizing the structure developed.

Responsibility of Owners

The owners of industry through the banking function or otherwise share in the responsibility for eliminating waste in industry. They have the duty particularly of assisting in stabilizing production.

Responsibility of the Public

Need of Public Interest. In the study of industrial waste, there can be no setting apart of the public as a separate group. The public comprises all groups, and the public's responsibility for eliminating waste is large. A campaign to increase the productivity of industry cannot be conducted without widespread interest and support.

Style Changes. In certain industries the consuming public is to a degree responsible for seasonal fluctuations because of the eagerness with which it accepts or adopts changes in style.

Distribution of Demand. The public can assist in stabilizing industry by accepting a sensible distribution of demand throughout the year.

Community Co-operation With Industry. Public and semi-public agencies can assist by definitely encouraging and supporting the efforts for elimination of waste. Bodies such as local chambers of commerce and other civic and community associations can bring influence to bear through local conferences with the different branches of industry.

Opportunity of Trade Associations

Trade associations should be formed in those industries lacking comprehensive organizations. Trade associations should promote programs for the standardization of cost accounting methods, the introduction of standardized material specifications, the establishment of production standards, and the standardization of equipment, and of finished products.

Opportunity for Governmental Assistance

National Industrial Information Service. A national industrial information service should be established to furnish timely, regular, and complete information on current production, consumption, and available stocks of commodities, supplementing the work of private agencies.

A National Statistical Service. A national statistical service should be established and maintained covering employment requirements and conditions throughout the country.

Principles for Adjustment and Settlement of Labor Disputes. A body of principles for the adjustment of labor disputes should be accepted which can be developed with experience.

Public Health Policy. A national policy regarding public health should be accepted and put into effect. The reports dealing with health, prepared in connection with this study by a group of physicians, indicate the importance of maintaining the health of industrial workers as a factor in production and as a means of eliminating one form of waste. These reports also declare for an aggressive, continuous, national public health policy.

National Program for Industrial Rehabilitation. The national program for industrial rehabilitation should be encouraged.

Nation-Wide Program of Industrial Standardization. A nation-wide program of industrial standardization should be encouraged by the government in co-operation with industry. In the standardization of design of product, methods of procedure, and number of models, there rests a large opportunity for the reduction of waste.

Revision of Federal Laws. Where Federal laws interfere with the stabilization of industry they should be revised in the interests of the whole people.

Duty of Engineers

The duty of engineers is a part of all the responsibilities previously stated in different recommendations. It is peculiarly the duty of the engineers to use their influence individually and collectively to eliminate waste in industry.

The Gantt Chart—I

Its Principle Technique, Application, and Use

By WALLACE CLARK

Consulting Management Engineer

MANAGEMENT is concerned almost entirely with the future. Its task is to decide on policies and to take action in accordance with those policies which will bring about a desired condition. Decisions which affect the future must be based on a knowledge of what has happened in the past, and while a record that certain events have taken place or that a certain amount of work has been done is of value in making such decisions it does not give us sufficient insight into the future. We must know *when* those events took place or the *rate at which* the work was done. In other words, the *relation of facts to time* must be made clear.

If management is to direct satisfactorily the operation of our industries under conditions of ever-increasing difficulty, its decisions and its actions must be based not only on carefully proved facts but also on a full appreciation of the importance of the momentum of those facts. *The Gantt chart, because of its presentation of facts in their relation to time, is the most notable contribution to the art of management made in this generation.*

The Advantages of the Gantt Chart

The use of a Gantt chart makes it necessary to have a plan. Recording that plan on a chart where it can be seen by others has a tendency to make it definite and accurate and to promote the assignment of clear-cut tasks to individuals. The plan is presented so clearly on these charts that it can be understood in detail and as a whole not only by the executive himself but also by those above him and by his subordinates.

The Gantt chart compares what is done with what was done—it keeps the executive advised as to the progress made in the execution of his plan and if the progress is not satisfactory it tells the reasons why. The executive's time is thus saved because each time a figure is received he does not need to compare it with past records and decide whether it is good or bad. He has determined once for all what figures will be satisfactory and has recorded them on the chart. The comparison of the accomplishment with the plan then becomes merely a clerical task and the executive is left free to study the tendencies and take the action indicated by the chart.

The Gantt chart emphasizes the reasons why the performance falls short of the plan and thus fixes the responsibility for the success or failure of a plan. Causes and effects with their relation to time are brought out so clearly that it becomes possible for the executive to foresee future happenings with considerable accuracy.

The Gantt chart is, moreover, remarkably compact. Information can be concentrated on a single sheet which would require 37 different sheets if shown on the usual type of curve charts. There is a continuity in the Gantt chart which emphasizes any break in records or any lack of knowledge as to what has taken place.

The Gantt chart is easy to draw. No drafting experience is necessary, for only straight lines are used. The principle is so simple that anyone with average intelligence can be trained to make these charts.

Gantt charts are easy to read; no lines cross each other and all records move with time across the sheet from left to right. Charts drawn in pencil or black ink convey an impression of practicability, simplicity, economy and strength which it is not possible to obtain by the use of colored inks or even squared paper. Since no colors need be used on Gantt charts, prints are as intelligible and effective as originals.

The Gantt chart visualizes the passing of time and thereby helps to reduce idleness and waste of time.

The Gantt chart presents facts in their relation to time and is, therefore, dynamic. The chart itself becomes the moving force for action.

The Principle of the Gantt Chart

In the Gantt chart a division of space represents both an amount of time and an amount of work to be done in that time. Lines drawn horizontally through that space show the relation of the amount of work actually done in that time to the amount scheduled. This is the feature which distinguishes the Gantt chart from all other charts. Equal divisions of space on a single horizontal line present at the same time:

1. Equal divisions of time.
2. Varying amounts of work scheduled.
3. Varying amounts of work done.

Thus it shows the relation of time spent to work done. Furthermore, since *knowledge of what has happened and when it happened causes action,* the past projects itself into the future and records charted in this way become dynamic. A single example may make this method clear.

A week's work is planned as follows:

Monday	100
Tuesday	125
Wednesday	150
Thursday	150
Friday	150

A sheet is ruled with equal spaces representing days (Fig. 1) and the amount of work planned is shown by

figures on the left side of the day's space. So far the chart shows the schedule and its relation to time.

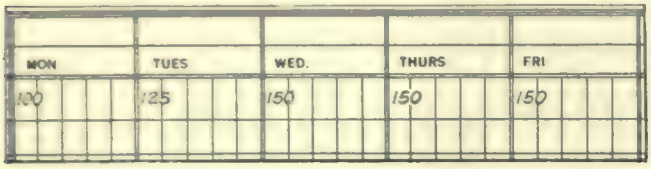


FIG. 1 GANTT CHART SHOWING THE DAILY SCHEDULE

The work actually done through the week was:

Monday	75
Tuesday	100
Wednesday	150
Thursday	180
Friday	75

This is charted as shown in Fig. 2.

Lines are drawn through the daily spaces to show a comparison between the schedule and the actual accomplishment. On Monday the space represents 100; only 75 were done, so a light line is drawn through 75 per cent of the space. On Tuesday 125 were planned; 100 were done; a line is therefore drawn through 80 per

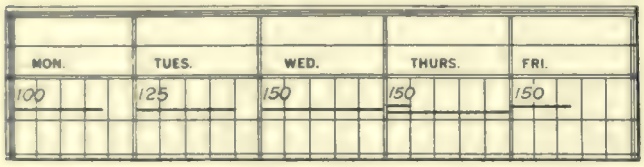


FIG. 2 GANTT CHART SHOWING THE WORK ACTUALLY ACCOMPLISHED

cent of the space. On Wednesday 150 were to be done and 150 were done, so the line is drawn through the entire space. On Thursday 150 were scheduled and 180 were done, i. e., 120 per cent of the schedule; a line is therefore drawn all the way across the space to represent 100 per cent and an additional line through 20 per cent of the space. On Friday 150 were planned; but only 75 were done; a line is accordingly drawn through 50 per cent of the space. The chart now gives a comparison day by day of the amount of work done and the amount scheduled and the relation of both schedule and accomplishment to time.

It is, however, desirable to know how the whole week's work compares with the schedule and so the figures representing the *cumulative schedule* are entered on the

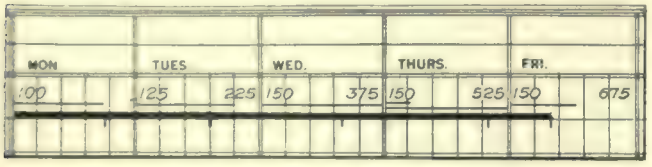


FIG. 3 GANTT CHART SHOWING THE CUMULATIVE SCHEDULE AND THE CUMULATIVE WORK DONE

right side of the daily space (Fig. 3). At the end of the day on Friday, for instance, the total amount to be done up to that time was 675. A heavy line is therefore drawn to show a comparison between the *cumulative work done* and the *cumulative schedule*. On Monday the heavy line is the same length as the light line. Of the 100 done on Tuesday, 25 have to go to make up the shortage for Monday. The remaining 75 are applied on Tuesday's schedule and the heavy line is drawn through 60 per cent of the Tuesday space. Of the 150 done on Wednesday 50 are needed to meet the schedule to Tuesday night and the remaining 100 are applied on Wednesday's schedule of 150, the line being drawn through 66 per cent of the space. Of the 180 done on Thursday 50 are used to meet the schedule to Wednesday night and the line representing the remaining 130

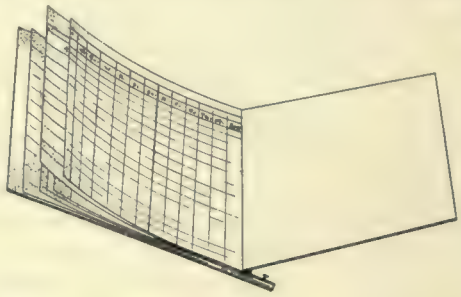


FIG. 4 HOW GANTT CHARTS ARE BOUND

is drawn through 87 per cent of the day's space. Of the 75 done on Friday 20 go to meet the schedule to Thursday night, leaving 55 to be applied to Friday. The cumulative line, therefore, shows us that on Friday night the work is two-thirds of a day behind the schedule. This chart (Fig. 3) shows the relation of the schedule to time; the work done each day in relation both to time and the schedule, and finally the cumulative work done and its relation to time and the schedule.

HOW TO DRAW A GANTT CHART

Size. Gantt charts can, of course, be drawn on paper of any size or shape. It has been found, however, that the most satisfactory size is 11 in. by 17 in. because, when records are charted by months, there is ample space for a complete year and when they are charted by days, two weeks can be shown on one sheet. A sheet 11 in. by 17 in. is also a standard size for binders and when folded once to 8½ in. by 11 in., it can be placed in a standard letter file.

Paper. If no copies of charts are needed or they are to be photostated, it is possible to use any kind or weight of paper, although bond paper 20 lb. in weight is possibly most satisfactory. When charts are to be kept a number of years, 28 lb. bond or ledger paper may be used.

If blue-prints of charts are desired, bond paper without any water-mark should be used, because on a blue-print a water-mark will sometimes show up as prominently as the lines drawn on the chart. The weight of the paper determines the time necessary to make the blue-print, i.e., the heavier the paper the longer it takes for the light to penetrate it. When paper is very light in weight, it crinkles and soils easily. The best results are, therefore, obtained by using a medium weight: 12 or 13 lb.

Binding. It has been found more satisfactory to

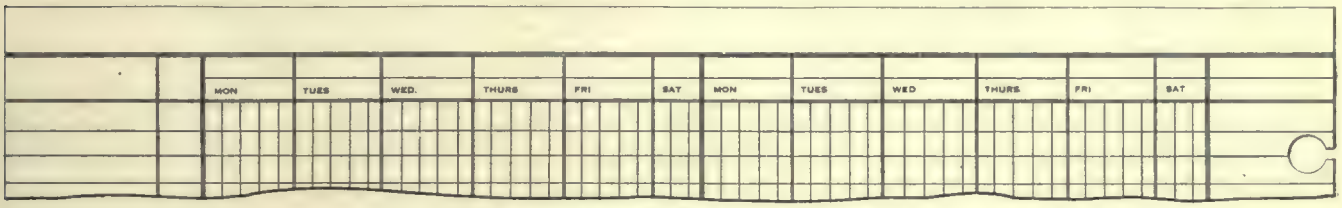
bind these sheets on the right rather than the left, for two reasons:

1. Records charted naturally move with time from left to right. This puts the index at the outer edge of the binder and makes it easy to find a specific item in a book of charts.
2. When the time shown on one sheet has passed, a sheet without indices is placed on top of it. In this way the weeks or months are built up on top of each other with only one index. (Fig. 4.)

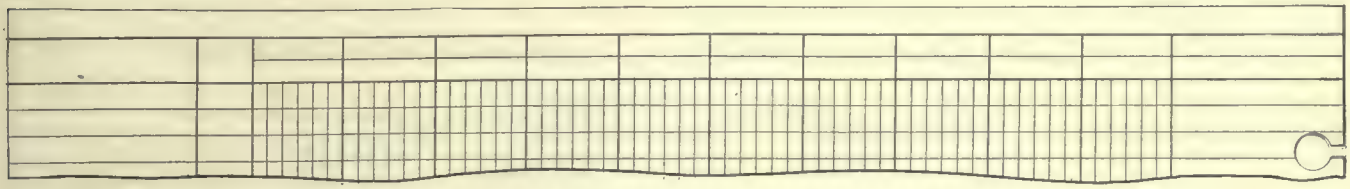
month's total. Separate days, weeks and months by heavy lines or by double or triple lines. (Fig. 5-C.)

Use black ink for ruling chart forms, since gray or colored inks are not so readily blue-printed or photostated.

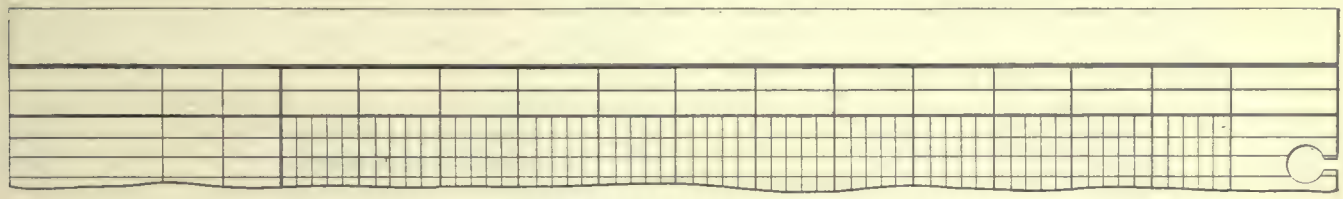
Horizontal Ruling. From the top of the sheet lay off a space about 2/3 in. high in which to write a description of the information contained on the sheet. Under that lay off another space 2/3 in. high in which to print or write the units of time and dates. On both sides of this space use double or triple lines. (Fig. 5.)



A—Sheet Ruled for a Record of 2 Weeks.



B—Sheet Ruled for a Record Covering 10 Weeks of 6 Days Each.



C—Sheet Ruled for a Record of 12 Weeks.

FIG. 5 STANDARD RULED SHEETS USED IN PLOTTING GANTT CHARTS

Perpendicular Ruling. First lay off from the right side of the sheet a binding edge of not less than 1½ in. —preferably 2 in. From the left side of the sheet lay off a space in which to write the necessary description of the work to be charted. This space may vary in width, but it has been found that one column 2 in. wide and another ½ in. wide will serve most purposes. In some cases, still another column ½ in. wide has been added.

The space remaining between the binding edge and the indexing space is divided into columns representing units of time, i.e., hours, days, weeks, months, years, etc. If the hours of the day are to be shown, the space is divided into two parts, each representing a week. Each half is then divided into the days of the week and each day into the working hours of the day. (Fig. 5-A.)

If days and weeks are to be shown, divide this space into ten equal parts for weeks and subdivide those spaces into five, six, or seven narrow columns, according to the number of days per week during which work is to be done. (Fig. 5-B.)

If months are to be shown, divide the space into twelve columns for months and subdivide each month into five columns, each representing 20 per cent of the

Through the remaining space rule horizontal lines three to the inch, which is double typewriter spacing for standard pica type. This spacing is also considered the best for written records. See that the first line on which records are to be entered is typewriter spacing (multiples of 1/3 in.) from the top edge of the sheet. It will then be possible to insert the sheet in the typewriter and turn the cylinder until the writing point is brought to any desired line without adjustment by means of the variable line spacer.

Where charts are not to be typed and it is desirable to get as much information on a sheet as is possible, the horizontal lines can be ruled four to the inch.

Printing the Form. These forms may be either printed or machine-ruled, the quantity required determining which method is the more economical. If any type is used on the form, such as the days of the week or the form name, Gothic type should be used. Since all the lines in the letters of that style of type are of equal weight, it will be readable when blue-printed or photostated.

Entering the Schedule. At the top of the sheet enter a description of the information to be charted on the sheet, placing at the extreme left the one or two words

which distinguish this sheet from others in the same binder. At the heads of the columns representing units of time enter the dates. In the columns on the left side of the sheet write a description of the work to be charted on the various lines.

The date or hour when work is to be begun is indicated by a right angle opening to the right, thus: ⌐ The date on which this is to be completed is indicated by an angle opening to the left, thus: ¬ The amount of work scheduled for any period of time is indicated by a figure placed at the left side of a space, thus:

| 10 |

The amount of work to be done up to any specified time is indicated by a figure placed in the right side of a space, thus:

| 40|

If these entries are made by hand, use India ink so that good blue-prints can be made. If they are typewritten use a heavily-inked black ribbon, and place a sheet of carbon face up against the back of the paper. The resulting blue-prints will show clear white typing.

Entering Work Done. Light lines represent work done during any given period of time, thus:

|——— |

The length of the line bears the same relation to the

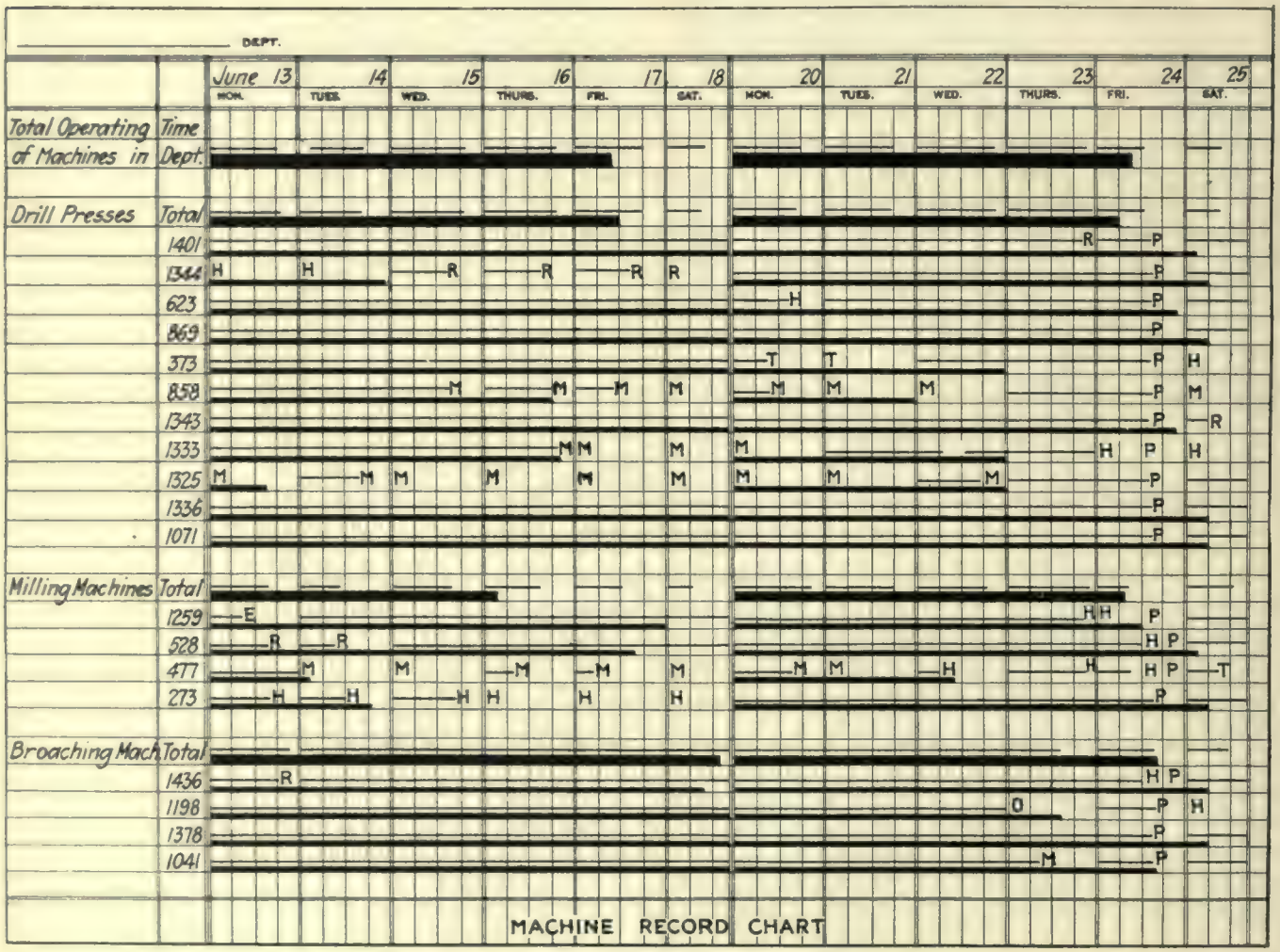


FIG. 6 A GANTT MACHINE RECORD CHART

LEGEND

| | Width of daily space represents working hours of the plant.
——— Time machine was running.
▬▬ Weekly total of individual machine.
▬▬ Weekly total of group of machines.
▬▬ Weekly total of all machines in department.

The portion of the daily space through which no line is drawn represents the time the machine was idle.

REASONS FOR IDLENESS

E—Waiting for set-up
H—Lack of help
M—Lack of material
O—Lack of orders
P—Lack of power
R—Repairs
T—Lack of tools
V—Holiday.

When there is more than one reason for idleness, the reason entered on the chart is determined by asking questions in the following order:

M—Is the machine ready to run?
O—Is there an order for the machine?
M—Is there material ready to be worked on?
T—Are there tools?
P—Is there power to run the machine?
H—Is there an operator for the machine?

width of the space as the amount of work done bears to the amount scheduled. Heavy lines represent the cumulative amount of work done and show its relation to the amount scheduled to be done up to any given date. thus:

When charts are drawn in shops, where they are for immediate use and do not need to be kept for reference, they are drawn up in lead pencil. If charts are to be

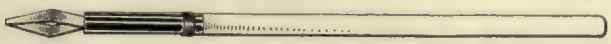


FIG. 7 LETTERING PEN USED FOR MAKING GANTT CHARTS

kept for future reference or are to be reproduced, India ink is used. Light lines can be drawn with a sharp pen point or a drawing pen; heavy lines are most easily drawn with lettering pens such as those shown in Fig. 7. Size No. 0, which is 1/16 in. wide, is the best for individual cumulative lines, while No. 1, which is 1/8 in. wide, is used for group totals.

Gantt charts fall into three general classes:

1. Man and Machine Record Charts
2. Layout Charts
3. Progress Charts

In the Man and Machine Record Charts, Gantt provides a mechanism to show the relation between what is done and what could be done by a man or machine. The gap between actual and possible accomplishment is idleness, that is, the neglect to make any use of time or a proper use of it. The Machine Record Chart shows when a machine is not made use of and the reason why. The Man Record Chart shows whether or not a man makes a proper use of his working hours; and if not, it indicates the reason why.

The reasons for idleness, which are emphasized by the man and machine record charts, indicate that steps must be taken some time in advance in order to avoid idleness. The Layout Chart is Gantt's mechanism to plan work so as to avoid idleness of men and equipment and to get work done in the order of its importance.

The executing of a plan is of equal importance with the making of that plan, and the Progress Chart is Gantt's mechanism to get work done by showing a comparison of the accomplishment with the plan and the reasons for failure to live up to that plan.

The purpose of the Machine Record Chart is to show whether or not machines or equipment are being used and, if not, the reasons for idleness. In a manufacturing plant the foreman uses a sheet ruled to represent the working hours of his shop or department. If he works an 8-hr. day he has each wide column which represents a day ruled off into four narrower columns each representing two hours. If he works a 9-hr. day, he rules the day off into four wide spaces of two hours each and one narrower space for one hour.

On the left side of this sheet the foreman or his assistant lists all the machines, benches, or work spaces in his department, arranging them in groups according to responsibility, if there are any subforemen. If not, they are arranged bq kinds of machines. At the top of each group he leaves a space for the total of that group and at the top of the sheet a line for the total of the department. (Fig. 6.)

Opposite each machine number the foreman indicates whether or not the machine has been running by draw-

_____DEPT

PRODUCTIVE MACHINES	PER CENT OF CAPACITY USED (10 20 30 40 50 60 70 80 90)	TOTAL HOURS OF IDLENESS	DETAILS OF IDLENESS HOURS DUE TO							
			LACK OF HELP	LACK OF MATERIAL	LACK OF ORDERS	LACK OF POWER	REPAIRS	LACK OF TOOLS	WAITING FOR SET-UP	HOLIDAY
Week Ending July 5th		1972	236	302	29	0	381	178	62	784
" 12		1478	259	436	250	0	333	152	48	0
" 19		1675	241	471	387	0	402	138	36	0
" 26		1478	206	523	115	88	357	147	42	0
August 2		1421	192	437	318	0	328	120	26	0
" 9		1336	180	413	318	0	303	104	18	0
" 16		1309	186	387	331	0	281	116	8	0
" 23		1205	173	307	336	0	294	83	12	0
" 30		1095	164	324	130	148	268	61	0	0
Sept. 6		1319	96	282	257	0	239	40	0	405
" 13		1151	168	253	154	0	178	29	0	369
" 20		873	101	206	340	0	191	35	0	0
" 27		882	83	263	460	0	64	12	0	0
Oct. 4		777	48	241	345	0	143	0	0	0
" 11		760	22	213	468	0	57	0	0	0
" 18		1035	35	178	416	0	38	8	0	360
" 25		815	16	192	558	0	49	0	0	0
Nov. 1		610	9	157	382	0	62	0	0	0
" 8		865	0	106	352	0	47	0	0	360
" 15		527	5	85	382	0	55	0	0	0

FIG. 8 A SUMMARY OF IDLENESS CHART

This chart shows how the running time of machines has been increased due to a knowledge of the causes of idleness.

ing a light line across the space to indicate how many hours the machine ran. The ratio of the line to the space is the same as the ratio of the hours the machine ran to the working hours of the plant. A blank space indicates that the machine did not run, and in that space a letter or symbol is placed to indicate the reason why. The letter indicating the reason is placed at the beginning of the space representing the idleness so that it would be bisected by the light line if there were any.

Under the light line a heavy line is drawn to indicate the cumulative running time of the machine for the whole week. The length of this heavy line is always equal to the sum of the light lines for the various days. The heavy line rests on the printed line and the light line is drawn about 1/10 in. above the heavy line.

The running time of the individual machine in a group is averaged and the light and heavy lines entered for the group total. In the same way the groups are averaged to get the total running time of the shop, and the lines are drawn at the top of the sheet. (Fig. 8.)

In this Machine Record Chart the foreman has a graphic record of the running of his machines which enables him to visualize his problem and to grasp the facts and the tendencies much more firmly than he could from any written record or from watching the machines. Moreover, the chart emphasizes above everything else the reasons for the idleness of machines, and so it indicates very clearly who is responsible for the idleness.

Since it is the foreman's aim to get work done, he studies the facts shown and translates the chart into action. He eliminates as much as possible of the idleness over which he or his subordinates have control. If machines have been "waiting for set-up," he plans the work of his set-up men more carefully, and, if necessary, trains an additional set-up man. If the machines are idle for "repairs," he does all he can to push the completion of the repairs. If the trouble is "lack of material," he asks the storekeeper for help.

A considerable part of the idleness of machines appears to be due to causes over which the foreman has no control, so he takes the matter up with his immediate superior, who may possibly be the superintendent.

In order to get a better idea of the progress made in the running of his machines, the foreman prepares a Summary of Idleness Chart (Fig. 8), on which he enters each week the one line which summarizes his whole department and he shows the hours of idleness due to the various reasons.

The foreman in whose office these charts are kept not only advances his own interests by keeping them, since they enable him to become a more important and capable man in the eyes of the management and of his workmen, but by the same means he calls to the attention of other individuals their responsibilities.

The Machine Record Charts are of great value to the superintendent because they bring to his attention the problems on which his help is most needed. He does not have to go around the shop asking his foremen what is wrong and frequently finding out only when it is too late. The obstacles which prevent his foremen from keeping their machines running are brought to his attention regularly and in detail. In order to get a comprehensive grasp of conditions, he has the records of all his departments summarized on an Idleness Expense chart (Fig. 9).

Because of his greater experience and broader authority the superintendent can be of most service in advancing production by helping the foremen overcome the obstacles with which they are daily confronted and which they report to him on the Machine Record Chart.

Week Ending June 18, 1921

	PER CENT OF CAPACITY USED (10 20 30 40 50 60 70 80 90)	TOTAL EXPENSE OF IDLENESS	DETAILS OF IDLENESS EXPENSE DUE TO						
			LACK OF ORDERS	LACK OF HELP	LACK OF TOOLS OR PATTERNS	REPAIRS	LACK OF MATERIAL	WAITING FOR SET-UP	LACK OF CRANE SERVICE
Total Plant		$7388	3277	1413	591	780	1022	57	248
Total Foundry		$4231	1850	934	517	429	253	0	248
Molding Floor # 1		166	145	21	0	0	0	0	0
" " # 2		529	253	66	116	94	0	0	0
" " # 3		817	155	165	142	107	0	0	248
Large Cores		546	156	42	188	70	90	0	0
Small Cores		675	235	182	63	87	108	0	0
Brass Foundry		774	761	13	0	0	0	0	0
Cleaning Room		724	145	445	8	71	55	0	0
Total Machine Shop		$3157	1427	479	74	351	769	57	
Dept. 1		409	77	99	18	131	27	57	
" 2		561	177	0	3	27	354	0	
" 3		527	300	9	0	0	218	0	
" 4		302	127	0	0	5	170	0	
" 5		1358	746	371	53	188	0	0	

FIG. 9 A GANTT IDLENESS EXPENSE CHART

This chart shows in actual dollars and cents what it costs to have machines idle.

Managing an Industry by Graphic Charts

How Current Facts Are Quickly and Economically Supplied to the Executive

By ARTHUR R. BURNET

Consultant in Business Statistics

IN technical engineering problems graphic methods have always been widely employed and highly valued by engineers. Along with mathematics, they have been a common medium of expression. As engineers have entered the field of management control, they have naturally taken with them these methods for making quantitative data stand out vividly. In the new field, engineers have found, of course, that the subject matter and the units of measure differ from those of the old. They have been already familiar with the principles and uses of computing charts and other graphic forms dealing with subjects like the relation of temperature to pressure, the efficiency of an engine, or the strength of materials. But a productive industry is managed by something more than the knowledge of the physical properties of things. It is a matter of promoting and directing an organization of persons whose work and activities are analyzed and measured by the management engineer in terms of production, wages, turnover, costs, sales, and profit.

Why Quantity Production is Necessary

So, when the management engineer begins to apply graphic methods to such subjects he is confronted by at least two new and striking facts. The first is that the data he must analyze are interrelated to a surprising degree. The technical engineer measures the efficiency of an engine and plots the performance curve. The resulting chart stands as an independent and separate study. But in industry, pay-roll is related to production, production to costs, costs to sales, sales to profit, etc., and therefore every management engineering chart, though complete in itself, should also be comparable with every other one, and must be drawn with due regard for the recognized interrelations of all the factors involved in the enterprise. And yet very few have given attention to this highly important matter, as is shown by the indiscriminate selection of scales and the utter lack of comparability of charts that is found even in technical articles and books on graphic methods.

The other striking fact that confronts the management engineer as he begins the application of graphic methods to industry is the comparatively large number of charts required. The very interrelations, to which reference has just been made, account for a larger number than would otherwise be the case, for, in order to secure flexibility in making comparisons, the unit card system, i.e., the plotting of one subject only on a card or page, is highly desirable, if not absolutely necessary. Moreover, one of the most valuable uses to which graphics in management engineering have been put is the elucidation of vital accounting reports, with which every large industry is generously supplied. Many of these commonly lie dormant for want of elucidation and interpretation.

"One of the greatest wastes in industry today lies in accounting reports," remarked the head of a well-known accounting firm, in a recent interview. And then pointing to a bulky report which had just been completed for a manufacturing concern at an expense of several thousand dollars, he continued: "They will look at the first few pages of that report, and afterwards file it away. If, by means of your graphic charts, you can get executives to study intelligently the facts of their business, you will render a service to American industry."

An idea of the number of charts required may be gathered by citing a few examples. A large steel company, shortly after the installation of a graphic department, plotted charts covering two years so as to be able to compare the current with the previous year. (Comparisons over longer periods than this are often desirable.) Charts were made for each of 50 products and included such matters as: production by weight; unit cost divided into producing labor, repairs, running expense, total works operating, and total costs; sales by weight and by value; ratio of unit cost to selling price. All of these charts showed monthly data and amounted to a total of 1,200. This was only a beginning. The same company later plotted commodity sales charts for 20 branches, which meant several hundred more charts. Work was also begun on unit cost charts covering more than 60 mills and departments. The operating executives of this company are able to follow by means of charts the production and costs from the ore to the finished rail or spike, and their comment on the result after the charts had been running a year was: "We wouldn't do without them." The company referred to now probably has a total of 10,000 charts. Other companies have 5,000, and many can get good results from comparatively few.

How Executives Use The Charts

Let us hasten to assure the reader, however, that in actual practice, no individual executive need see all of the charts. Although they may be kept in one place for the sake of convenience, they are more often segregated according to the departments or persons they most concern. Just as there are master blue-prints and detail blue-prints, so the chief executives may be concerned with only the key charts, while the

detail charts or working drawings, so to speak, are used by subordinates to plan and direct the work of their various departments. For example, the chairman of the board of a very large industry sits in his New York office and by means of a selected number of about 200 key charts keeps in close touch with plants that are scattered in various parts of the country, while the working charts are available at the various plants.

An industrial enterprise can be readily managed by means of the periodic study of the comparatively few key charts. The executives, if they wish, may examine at regular intervals all of the charts including the detail ones, but this is not necessary since the statistician has the charts constantly under his supervision. It is his duty to bring to the attention of the executives exceptional curves or curves that have exceeded limits previously set. By this method better executive control is exercised over an industry, with less effort and uncertainty.

If charts are to be used not merely as summaries of past events but for the current management of an industry, a means must be provided for producing them in large numbers. As every management engineer knows, the way to secure quantity production is to standardize on a few types and adopt uniform methods of manufacture. The recipe holds good for commercial curve plotting.

In the past most charts were prepared entirely by hand. It required somewhat of an engineer to select the proper paper and the scales, and somewhat of a draftsman to do the drawing and lettering. But the charts described in this article are made on uniform letter-size sheets, by regular office clerks, on an ordinary typewriter. Standard chart forms, scale selection tables, mechanical plotting devices, and other scientific means are employed to turn out the charts accurately, quickly, and cheaply.

THE "Z" CHART

The type of chart that has been found best adapted to meet most of the demands of management engineering is familiarly known as the "Z" chart because the three curves of which it is composed often combine in the shape of the capital letter Z. In its original form this chart was first applied by T. Russell Robinson to the executive control of public utilities, but since that time improvements have been made in the technique of its construction, and its use has widened so as to cover every phase of production, cost, sales, and finance. Ninety per cent of the charts needed to interpret an industry graphically may be of the Z type.

An example of the Z chart is seen in Fig. 1. Let us suppose that the subject matter is the monthly production in tons of a certain company for the year 1915. The chart is normally studied while resting on its long side, since that brings the curves into proper position. A person will readily accustom himself to reading all of the typewritten matter without turning the chart around. This method of studying the chart is particularly desirable when charts are examined in the files without removing them.

At the bottom of the chart the numbers 1, 2, 3, 4, etc., indicate the months of the year. The first 12 in the series stands for December of the previous year. The data for this month are plotted on the current chart not only to locate the position of the curves at the end of the previous year but also for the purpose of forming an almost continuous curve extending over 24 months, when two charts are placed side by side and overlapped.

The vertical lines represent the months of the year. Opposite each monthly line at the top of the chart are typed the actual accounting data for the individual months. The executive can therefore use the charts as purely accounting records, or he may visualize the amounts by means of the curves. It is a good rule that the data should always accompany the curves on the same sheet.

A THREE-FOLD PRESENTATION OF DATA

There are three curves corresponding to the three columns of figures. The lower solid curve marked "Month" represents the month to month production in tons, as given in the column headed "Current," and is plotted according to the set of scale figures nearer to the field rulings. Since distance above the base or zero line represents quantity, it is easily seen that in January, for example, the amount 75,503 is represented by a point above the horizontal line against which is placed the scale figure 50,000.

The broken line running in a diagonal direction across the field and marked "Cumulative" represents graphically the middle column of figures at the top of the chart. The cumulative is formed by adding February results to January, March to the sum of the first two, April to the sum of the first three, etc.

The upper broken line marked "Moving Annual Total" represents the uppermost column of figures. This is the most important curve of all. It is found by adding the total of the current month to a total of 12 months and subtracting the corresponding month of the previous year. By continuing the process of addition and subtraction, the complete moving annual total is obtained. This curve is especially valuable because it represents an annual rate, and since each plotted point contains the results of 12 months, it is subject to much less fluctuation than the current curve, which covers only month to month periods. Because it eliminates seasonal fluctuations and largely overcomes brief accidental changes, it is a surer and safer indication of the trend of the industry than are the other curves. Management engineers who are accustomed to analyze thousands of these charts give most attention to the moving annual total curve. Clerks in statistical departments have dubbed it the "mat" from the three initial letters of its name.

The importance of the annual rate of an industry brought right down to the current month or even week is not fully realized. You meet your friend, the manufacturer, at the club, and in the course of the conversation you inquire how much business he is doing. The chances are he will name the amount reached at

the end of the fiscal year. But the fiscal year may have ended three, four, or five months ago, and all sorts of things could have happened since then. If he had given you the figures for the year ending with the current month he would have furnished you the most recent information, and at the same time included summer and winter, good season and bad. The story told by the mat curve is a complete story. Place a Z chart above the one for the previous year. Notice that every time the mat curve slopes upward this year, the current curve this year is higher than the current curve for the corresponding month last year. A little reflection upon the way in which the moving annual total amounts are found will make clear why this is so.

The mat curve and the cumulative curve are plotted according to the scale figures farthest away from the field. It will be noticed that these scale figures are five times as large as the ones used in connection with the current curve. This is so because the cumulative and moving annual total amounts are naturally much larger than the current monthly amounts and because the cumulative and mat curves would run off the field if they were plotted on the current scale. Similarly, if the current curve were plotted on the scale of the other two it would flatten out, and hardly be distinguishable from the zero line.

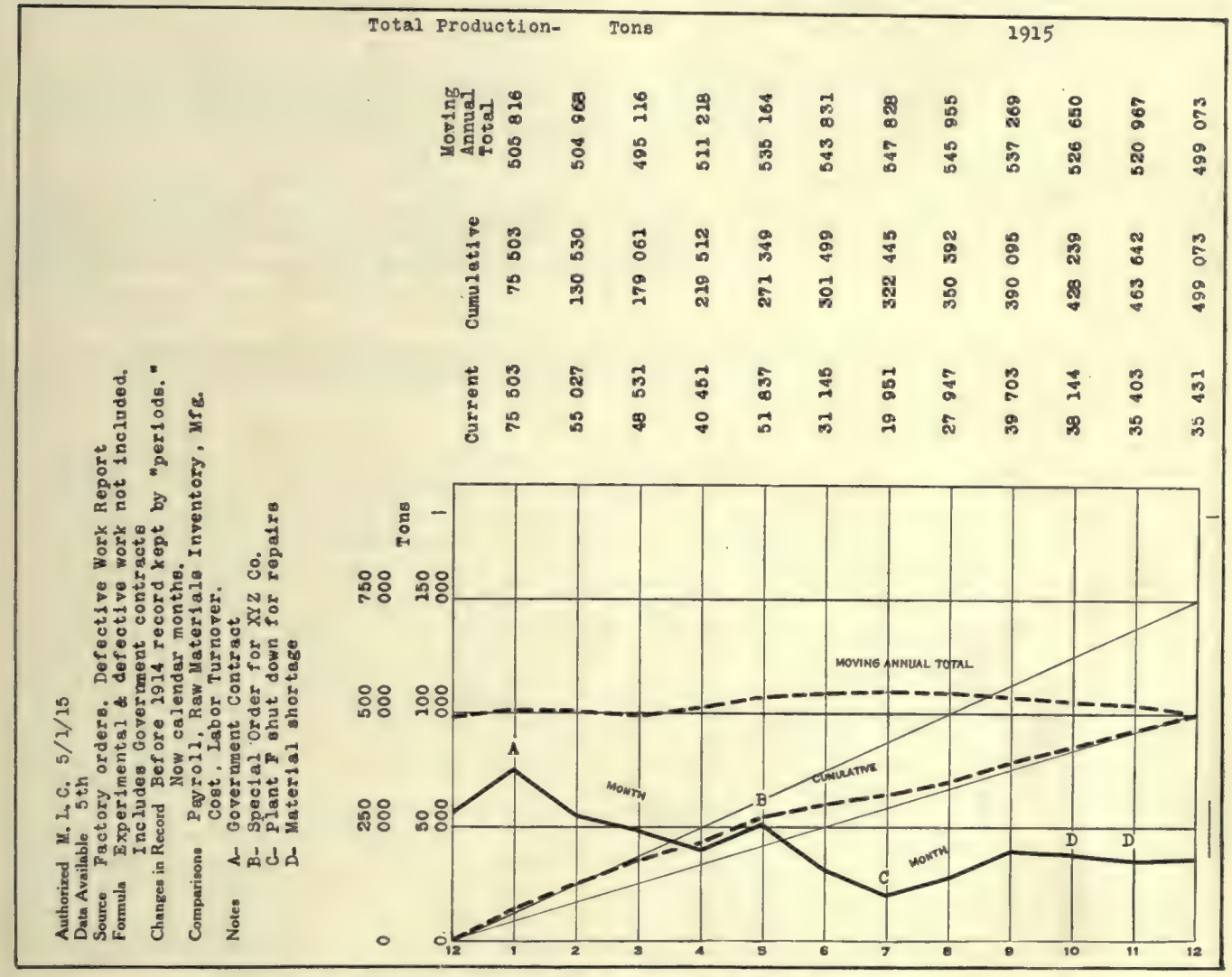


FIG. 1 A STANDARDIZED CHART SHOWING A YEAR PRODUCTION

A standardized monthly "Z" chart showing monthly, cumulative, and yearly data. It is drawn on a letter-size sheet. The co-ordinate field measures 4 in. by 6½ in., and the narrow margins at the bottom and side are only ¼ in. in width, making it easy to compare curves on separate charts by overlapping the sheets. With the exception of the title, all of the typing can be done on an ordinary machine without changing the position of the paper. The chart contains all information essential to the understanding of the data and of the curves.

Scale figures should be given little or no attention on the part of the executives. In the first place the actual amounts are always typed at the top of the charts, and it saves time to read them when they must be read instead of estimating from scale figures. Moreover, the parts of the curves between the plotted points have no value, and there is, therefore, not the slightest need to refer to the scales in reading the chart. The scales are used in plotting and for making future estimates. It is a little hard for engineers to close their eyes to the scales because they have been accustomed to the reading of scale figures in technical

engineering charts. Such charts are generally read by reference to scale figures because all of the points in the curves, both plotted and imaginary, have values. For example, in a curve showing the relation between temperature and pressure, for every given point representing pressure there is a corresponding point representing temperature. But in accounting charts, such as we have been describing, it is seldom true that the points between the vertical rulings have real values. In Fig. 1 we cannot read the amounts for the 13th or the 25th of the month but only for the entire month.

It will be noticed that the mat and cumulative curves meet on the last month of the year. This is so because each plotted point in the one represents 12 months, and the other builds up to the same total. This property of the two curves has special significance when it comes to the making of estimates ahead, which all management engineers at some time are required to do. Such estimates should be more than guesses; they ought to approach as nearly as possible to a scientific analysis of past and present performance, thus leading to what may be expected.

It is easy to see how Z charts help in this problem, not alone by showing the standard shapes of curves which result from the natural growth and progress of the industry, or as the result of seasonal changes, highly important though these may be, but particularly by the extension or extra-polation, graphically, of uncompleted curves as a means of forecasting future performance. Suppose the latest entries on the chart in Fig. 1 were for the month of July and we were required to estimate the total for the year. By extending the trend of the mat curve and by continuing the cumulative until the two met in December, it would be possible to arrive at a very close estimate. Of course due allowance would have to be made for all of the

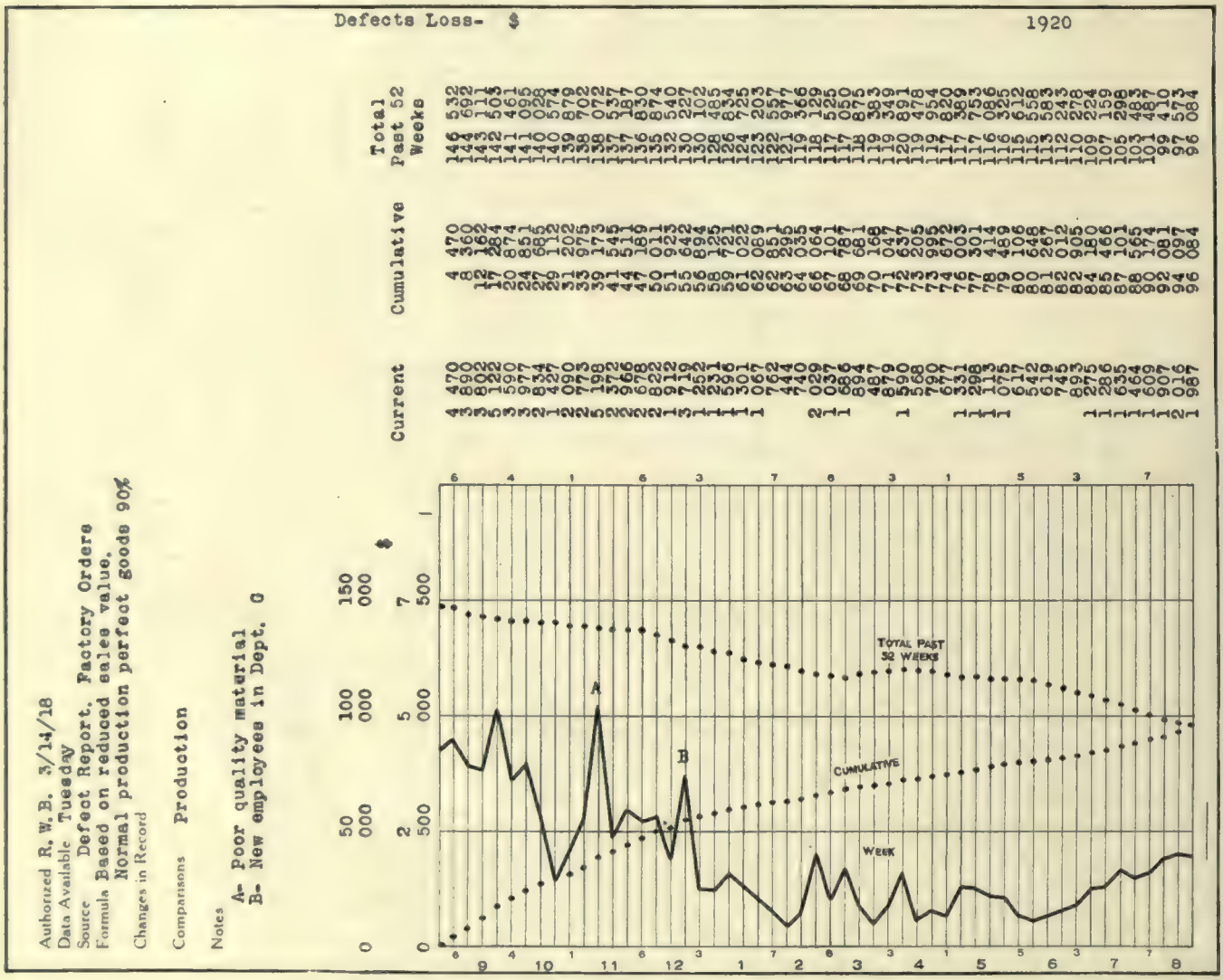


FIG. 2 A STANDARDIZED CHART SHOWING THE LOSS DUE TO DEFECTIVE MANUFACTURE

A standardized weekly "Z" chart drawn on the same principle and having the same dimensions as Fig. 1, making it possible to compare weekly charts with monthly charts. This chart form can be adapted either to the calendar or fiscal year. The example shows a fiscal year beginning in September. The numbers in the narrow margin at the bottom indicate that the first Saturday in September, 1919, was the 6th, the first Saturday in October was the 4th, etc. The chart is given the date 1920 because most of the months were in that year.

known factors, past, present, and future. If the industry were strongly seasonal, last year's finished curves would serve as guides.

An example of close estimating in an admittedly erratic business—motion pictures—came to the writer's notice. Estimates were based on charts drawn to represent a year divided into 52 weeks. In making the estimates, more than 20 branch sales and branch expense charts were used in addition to the grand totals. The year had three months yet to go, which may not seem to be a very big gap, but it should be pointed out that there were no charts of the previous year to serve as guides. Estimates were needed for the purpose of planning expenditures and for determining probable returns on capital invested, and they had to be attempted. When the actual figures became available it was found that the grand totals were only about 2 per cent above the actual, and that in the case of many branches the two differed by a few dollars only.

Expected vs. Actual Performance

Quota lines are easily established on the Z chart by drawing them from zero at the base of the first vertical field ruling, diagonally across the chart to the height it is desired should be reached at the end of the year. This quota line becomes virtually a cumulative curve. It is often desirable to draw several such lines as, for example, the two shown in Fig. 1. By comparing actual cumulative curves with quota lines the management engineer can quickly see whether production is running above or below the established rate. In Fig. 1 it is easy to see that production for the first two or three months ran at an annual rate of about 750,000 tons and that it was above the rate of 500,000 tons for the entire period.

Charts can be used to show weekly data just as effectively as they show monthly data. Fig. 2 is a weekly chart and illustrates the application of graphic methods to the elimination of waste in manufacturing. Although the period of time differs from that of the chart in Fig. 1, the chart has the typical elements of the Z form. In the case of this particular example the year is not the calendar year but a fiscal year beginning in September. The months are indicated by the larger figures at the bottom of the chart, and the weeks, ending Saturdays, by the smaller figures. Thus it is seen that the first week of September, 1919, ended with Saturday the 6th, and that the first Saturday in October was the 4th, etc.

The operating executive of a large plant was dismayed at the amount of defective goods caused by careless handling of machinery, the misuse of materials, and lax inspection on the part of his men. Efforts to reduce the amount of waste were not successful until it was realized that the only effective way of bringing the matter home to the men was to show the condition graphically, and to show it not in percentages or in square yards but in dollars and cents. Accordingly the various kinds of defects to which the goods were subject were given a money value which was really a deduction from the sales value of the finished goods.

In the weekly noon meetings of the foremen, after lunch had been served by the company, the charts were thrown on the screen and explanations called for. If during the week Department B had caused a loss of $1,000, the foreman of that department felt the matter keenly. There was friendly rivalry in keeping losses low and many an attempt made to "pass the buck" by proving that the goods came to Department B from Department A in a defective condition. This promoted better inspection. Reduced loss could not hide behind decreased production, since the production charts were always shown along with the "defect charts." The concrete result was that in a year's time $50,000 had been saved in one plant alone.

Cost accounting *657.524*

The Elements in Manufacturing Cost

By FREDERIC H. LELAND
Leland, Knowlton & Hanks

A CLEAR definition and record of the elements in manufacturing cost are essential to the engineer or manager who realizes that there are many factors to be considered when reviewing such cost. It is necessary to keep clearly in mind the relative importance of each element in cost and to maintain the proper relationship between them and the total cost of product.

An attempt is made in this article to differentiate between the various elements and to show the relationship which exists between them in a representative and successful business which has withstood the strain of lean years and of prosperous years for a decade.

The business taken is one in the stove and range manufacturing industry that produces a standard product, varied from time to time in such details as style of finish, location of ovens, hot plates, and broiler, to relieve what would otherwise be the monotony of a single type of stove or range. Changes are also made to adapt stoves and ranges for the use of different kinds of fuel or to make the particular stove or range more adaptable to conditions of use, as in the combination of wood, coal and gas ranges in a single range, and the combination of coal and electric stoves within the one unit. Other changes are sometimes made to increase sales or to reduce the cost of manufacture, and in all of these adaptations consideration is given to the elements in manufacturing cost and to sales advantages. The elements in cost are first considered in groups, then the detailed cost factors in each group are studied.

Three Groups of Manufacturing Costs

The elements commonly grouped in manufacturing cost in the stove and range industry follow the operations in the foundry and in the manufacturing and mounting departments. These groups are:

A. General Plant Expenses.
B. Foundry Cost and Expenses.
C. Manufacturing Departments Costs and Expenses.

Each of these groups may then be subdivided in turn as follows:

Group A includes all items of a general nature and deals with the totals against the plant for insurance, depreciation, taxes, etc., salaries, and other items which are paid from a distant administrative office and are chargeable to the cost of production.

Group B cares for the direct foundry cost of castings and expenses, including:

1. Foundry foremen's salaries and other costs and general expenses of the foundry department necessary to produce finished castings as such, including pattern repairs, flask repairs, coreroom cost and repairs, cost of shaking out, cleaning, etc.
2. Moulding costs for sand, kerosene, etc., piecework, "cast" compensation, day labor, if any, etc.
3. Cupola cost of hot metal, pig iron, coke and other fuel, proper proportion of overheads, cupola labor, re-lining, etc.

Group C takes care of the manufacturing departments' costs and expenses, including:

1. Indirect labor
2. Indirect material
3. Direct material, purchased parts, trimmings, etc.
4. Direct labor.

The foregoing plan of group accounting includes quite sufficient detail for any stove and range foundry manager's attention. Further details are of the nature of isolated facts, the control of which is a responsibility of the various department foremen, whether they be working foremen or supervising foremen, and the results of their efforts, whether good or bad, are automatically reflected in the group figures dealt with by the manager.

Costs Must Be Established for Entire Business

Before analyzing the elements in the cost of manufacture of any particular stove or range it is essential as a whole, are applied to the different sizes, styles, and gards the whole line of stoves and ranges manufactured, and then to note the extent to which the cost facts of a particular stove or range differ from the averages of the whole line produced.

To do this most effectively it is necessary first to determine what volumes of sales and production are required at current prices, less discounts, if any, in order to operate at the zero point of either profit or loss; a base point below which sale and production cannot long be allowed to go and continue in business. The zero point of sales and production having been determined, the following ratio ranges are permitted in the elements of manufacturing cost, and any serious departures from these ratios are causes for immediate investigation and action to correct discrepancies in either sales, quantity of production, or in the cost of production.

The following are consistant ratio relationship between cost factors, profits, and sales:

Sales.....100 per cent	
Profits	11.0 per cent
Administrative and Selling Expenses.....	22.0 " "
Manufacturing Costs.....	67.0 " "
	100 " "
Manufacturing Cost.....100 per cent	
Group A. Plant General Expenses.....	11.5 per cent
Group B. Foundry Costs and Expenses.....	48.0 " "
Group C. Manufacturing Departments Cost and Expense.....	48.5 " "
	100 " "

These latter cost figures are then analyzed as follows:

Group A. Plant General Expenses.100 per cent	
1. Insurance and Taxes.....	11.3 per cent
2. Depreciation	24.2 " "
3. Factory Management, Office Salaries and Other Items Paid by the Main Office and Chargeable to Production.....	64.5 " "
	100 " "
Group B. Foundry Costs and Expenses, 100 per cent	
1. Foremen's Salaries, Repairs, Coreroom, Cost Shaking Out and Clearing.....	19.0 per cent
2. Moulding, Labor, Sand and Supplies.....	41.0 " "
3. Hot Metal, Material, Labor and Repairs..	40.6 " "
	100 " "
Group C. Manufacturing Departments' Cost and Expense.....100 per cent	
1. Indirect Labor.....	5.0 per cent
2. Indirect Material.....	12.0 " "
3. Direct Material—Purchased Parts, Trimming, etc.....	57.0 " "
4. Direct Labor.....	26.0 " "
	100 " "

The foregoing percentage relations of the elements in the cost of manufacturing the company's product as a whole, are applied to the different sizes, styles and finishes of stoves and ranges in a series, and whenever the cost of a particular size, style, or finish in a series consistently shows higher cost factors than the average of the line as a unit, sales are discouraged, and the offending stove and range is eventually dropped from the catalogue unless its cost can be reduced or its selling price increased.

This plan of percentage comparison between the elements of the manufacturing cost in one foundry operates in similar fashion when applied to several foundries controlled by one corporation, and in the latter case a statistical department is constantly comparing the results of operation, one plant against another, and against the sum of the costs and sales of all the plants.

In some instances within the writer's experience manufacturers in different parts of the country making the same kind of goods exchange comparisons of their cost of manufacture, and are thereby led to effect economies in manufacture that had previously escaped them.

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658.4

Is Personnel Management Essential Now?

Pressing Labor Problems Must be Solved in Periods of Force Reductions as Well as in Times of Shortage of Workers

By EARL B. MORGAN

Director, Employment and Service Departments, Curtis Publishing Company

DURING the past four years employment departments have been springing up in industry like mushrooms, and it has been apparent to any close observer that the bulk of this development was stimulated by employers' wild scramble for help in a seller's labor market. Frantic in their needs for help, employers were willing to take on all measures that held out any prospects of assistance in meeting the crisis. Labor was King! But there came a change. The recent curtailment of production put the employer back in a buyer's market. Now, Employer is King!

This sudden shift in the stage setting has quite naturally put the burden of proof on all employment managers to show why they should exist. Are their departments ceasing to function merely because there are more workers available than jobs? Is all that they can contribute toward efficient management, merely "shooing in help at the back door"? Has the sudden shift in the scenery entirely eliminated the big, broad problem of dealing with the relations between the employee and employer? The supreme test of employment management has come. Is it an essential or non-essential?

Rendering Service—The Function of Managers

Let us look at the situation and analyze it. Whenever a new department is inaugurated, there is generally some very good and substantial reason for making the move; and so, when the first employment department was opened up in an industrial plant it was probably because of the fact that the management badly needed employees; and it wanted to set up some machinery which could be relied upon to provide on schedule employees of the quality and quantity required. In other words, the sole function of this first employment department was service.

It is doubtful whether the management in creating this first employment department gave even a passing thought to the idea of reducing labor turnover, for labor turnover was then an unknown term and its liabilities had not been established in the consciousness of management. In the course of developments, it was probably discovered, however, that reduction of labor turnover came as a by-product of applying scientific methods of employment. It is also a question whether this management inaugurated its employment department with any conception of industrial relations as developed today with its so-called labor policies. The sole purpose was *service*—obtaining an adequate and competent working force when it was needed.

This idea of service is a particularly good thought to keep in mind these days when scores of managements are asking themselves: Why keep up our employment department? We used to get along without it. Why maintain it now when the small amount of help we need is plentiful? These and other questions of a similar tone, all stimulated by the spirit of retrenchment and economy now so prevalent, are being presented daily in more than one management council.

So today we find our youngest member of the management family—Personnel Management, Employment Management, Industrial Relations, or whatever we choose to call it—fighting to hold its place under the industrial management household roof. The acid test is being relentlessly applied and we find many employment managers who have not "stood the gaff" already discarded as "non-essentials," while others are sitting on the anxious seat wondering if it is going to be their turn next.

The Failure of Employment Managers

We likewise find many employment men walking the streets today who but yesterday were proudly defending their sacred right to hire and fire against the onslaughts of foremen and department heads; and this is probably the very reason why they are now on the streets instead of giving their foremen and department heads some real service in obtaining and maintaining a competent working force. All they did was to hire and fire the workers. Still others are probably among those missing because they had the "policy" bug, and thus neglected their first obligation—obtaining workers. They had been building the superstructure without having first laid a solid foundation—service.

But is it not a good thing that this refining process is now being applied to the melting pot of employment managers and near employment managers, who have recently migrated from every calling—engineering, clergy, social work, law, medicine, and what not, without regard to qualifications for the work—to this "attractive," "interesting," "wonderful," and "full of opportunity" profession? Is it not going to mean that after the slag is all drawn off there is going to remain the pure product, real personnel managers, void of all frills and furbelows, who can be depended upon to handle labor problems in an efficient manner without the camouflage of such mysteries as psychology, phrenology, and the like?

As we survey the industrial field of sole survivors, the personnel managers who were able to "show" that

they were essential, quite naturally the question arises: How did they "show," what did they "show," and what are they now "showing" that enables them to hold their own against the inevitable wave of retrenchment? The answer is simple: First of all they organized a department which could be relied upon to recruit and select competent workers, and then they proceeded to sell this service to the entire organization. Furthermore, they did not allow themselves to be sidetracked from this objective until they had it established as solid as a rock. Moreover, not until the entire organization had been sold to scientific employment methods did they commence to build the superstructure of activities directed toward maintaining a competent working force.

To show how little some personnel managers have realized their opportunity, think of a management throwing overboard its personnel division during the very time when there existed a real personnel problem—reducing the force. There would seem only one answer in such a case; that the personnel department had not convinced the management that it could be of vast assistance in meeting such a problem. If assembling a working force is a personnel problem, and one to which scientific employment methods are applicable, then is not disassembling one also? The question almost seems to answer itself.

Present-Day Problems of Employment Managers

It seems to be rather easy for many managements to take on the attitude that there is no labor problem today. True, there is not one of supply, which seems to be the only phase recognized by some; but just because we are not now having a hectic time recruiting a supply of labor from which to select, does not mean that the selection problem is simplified. Rather, it would seem to complicate it, for instead of taking the only one or two workers obtainable in a short market, we now have for the first time in recent years a real opportunity to show what kind of "selectors" we are. An employment manager can no longer alibi the issue of poor help with—"He was the only one I could get." He is in a buyer's market, and unless he is a good buyer he will soon be a seller—of his own services to another employer.

But why select now? "We are not putting on any labor now," says the management which has dropped its employment department. "Hang out the old familiar sign, 'No Help Wanted Today' and fire the employment manager. Nothing for him to do!" Probably not, because he never showed that at such a time he could be essential to good management; indeed if the facts were known he was even a luxury during prosperity.

Such a management is oversold on labor, and one can almost imagine its attitude in a seller's market for its product. It hauls in its salesmen off the road and cuts out all advertising. "All unnecessary!" it says. "Couldn't make any more even if we got orders; can't fill what we got." That their customers, jobbers, and the public at large might even forget them and their product never occurs to them, and that some day they will need all the consumer demand they can stir up is not a part of their scheme of selling.

Contrast this now to a concern with a live employment department, applying all the sound principles of modern merchandising to insuring its labor market. When labor is coming to its door in an attitude receptive to the job, it does not turn a deaf ear, but is sympathetic and extends the same courteous consideration that a wise merchant does to his customers when he is oversold. Such an employment department carefully interviews every applicant, makes each and every one feel welcome, and catalogues them so that they will be available when help is needed. Will applicants forget such treatment when a seller's market for labor exists again? Try it and see.

Another function of the employment department during dull periods is to help refine that part of the organization which still remains by replacing inefficient workers with better material, and this can only be done if the supply of workers is being carefully analyzed from day to day. Would a purchasing agent be fired when there is no buying to be done? Hardly, at least not by an efficient management; for some day buying will suddenly be resumed and to buy to the best advantage will require knowledge of the markets. The purchasing agent is today closely watching his market so he will be ready; so also the real employment manager is studying his market and courting favorable public opinion.

Yes, these are hard times for employment managers, some of them. For others, the real ones, it is a pleasure to be in the game. Never has there been such an opportunity to do real constructive work; to get the employment machinery all tuned up to meet the labor load which is coming when business picks up just as sure as this is black ink on white paper.

But there is more work for the real employment manager than that just indicated, and there seems no better method of setting down in program fashion just what a personnel department can do now during present business conditions, than to consider in order all the activities that have been developed and recognized so far in personnel management, and to evaluate them as assets or liabilities.

The Personnel Requirements of the Present

First of all, with the absence of daily pressure to meet actual requisitions for help comes a real opportunity to analyze the present force. Each employee should be carefully rated to be sure that he is the best available for the job. It should be kept in mind that during recent years poor material in a great many cases has crept into organizations. Now is the time to weed it out. If an employment department will apply itself to this problem it will be surprised to find how many incompetents are stored away that should be liquidated. In other words, to take an inventory of the human equipment is a good program for today.

It has also been difficult, due to the stress of forced production under which we have been operating the

last few years, to make thorough job analyses. Obviously, therefore, now is the time to bring this necessary activity up to scratch. Likewise a few employment departments have established a *liaison* with the planning department so that they are kept in constant touch with production schedule requirements. Now is the time to perfect the machinery so that the manpower is planned with the same precision as are other factors of production. It is apparent, therefore, that although there are few pressing and immedate requisitions for help, there is still enough useful work along the lines of this first major activity of personnel management—personnel requirements—to keep busy.

THE PERSONNEL SUPPLY OF THE FUTURE

As already mentioned, now is also the time for the wide-awake employment department to study its market. Existing relations with the various agencies through which help can be obtained should be strengthened and maintained and new ones should be established. The trend and tendencies of the labor market, locally and nationally, should also be constantly surveyed. We have already spoken of the importance of building up a carefully classified reserve list of qualified applicants.

So much for the external supply. Now what is there to be done with the internal supply that is profitable? When production is being carried on at high speed it is very difficult to maintain a careful analysis of the present force of employees so as to be prepared to advance those already in your employ into vacancies above. So in times such as the present, it is wholly desirable to survey carefully the qualifications of each individual and have the results of such surveys available to assist in picking out men from within when the vacancy occurs. The organization chain is no stronger than its weakest link, the understudy, and industry has much to learn along this line from the examples set by the big-league baseball teams and theatrical troupes.

PERSONNEL SELECTION AND MAINTENANCE

During recent years it has not been so much a matter of selecting workers as of taking what was available, but now real selecting ability has a chance to come into its own. Not only, therefore, should the interviewing staff be tuned up to the highest pitch, but the executives of the organization should be familiarized with the selection policies and methods so that there will be co-operation all down the line.

Again, it is difficult to develop the various maintenance activities, such as mutual benefit associations, savings plans, vacation plans, legal aid, house organs, and the like, under the pressure of production and constant labor turnover; but they can be solidly set up in times such as these. If so, then, they become established institutions capable of rendering valuable assistance in maintaining morale when it is most needed, that is when labor is scarce. The activities of this nature which yield real results are not the set-up-over-night expedients, but rather are the ones that have the strength of age, performance, and tradition behind them.

The study of economic trends and tendencies is just as important in a business depression as in prosperous times. What policy is best as regards wages is very important. Should they be reduced, and if so, how much? Many serious mistakes are made by ill-informed managements that could have been prevented by having the guidance of an employment department which was keeping abreast of the situation. It is good insurance, therefore, against such situations for every employment department to keep a running survey on cost of living and similar economic factors which affect terms and conditions of employment.

Relations with foremen and other executives can be strengthened by personal contact and conference during normal times in a way which will be very beneficial when the wheels speed up again. Instruction not only of workers but also executives can also be most advantageously developed right now. In fact, there never was a better opportunity to refine and improve the executive force than now.

SOME WORTH-WHILE ACTIVITIES FOR PRESENT TIMES

Then there is accident prevention, which is often neglected under pressure, not only the mechanical safeguarding but also the educational phases of it. The study of fatigue, monotony, and insanitary and unhealthful conditions are other worth-while activities, especially adaptable to slack times. Few personnel men give adequate attention to the inroads made into the productivity of the force by tardiness and absence. These are likewise well worth most careful study.

The best test of a personnel record system is: Does it supply information that is required and when it is required? If not, the machinery should now be overhauled and rebuilt to meet requirements. During periods of heavy hiring and turnover, there is need of a smooth-running machine and, furthermore, there is then little time to design or construct it. Dull periods, however, present an opportunity to rebuild the system. Most all personnel record systems are carrying excess baggage which can be very properly dumped overboard now by a careful study. The simpler the system, the better it will function.

Much attention is being directed at present, and rightly so, to the problem of unemployment. Some go so far as to say that the fear of unemployment is at the root of all our industrial unrest. While this may be putting it a little strong, there is no doubt that this feature of industry must be bettered if our industrial situation is to be improved.

Just what can be accomplished immediately to remedy the situation is problematical, but there is no doubt that the achievement of definite progress will not commence unless the management establishes and maintains throughout the various extremes of economic conditions, a competent personnel department whose functions shall be intelligent hiring, placing and maintenance of labor. And furthermore, this work

must be done by a competent man of large caliber, one who is capable of managing the entire scope of relations between employer and employee.

At the risk of repetition, let me again state in closing that while many organizations at the present writing are either entirely doing away with their personnel departments or very materially reducing them to such an extent as to minimize their usefulness, such moves are most serious mistakes. Now is the best opportunity to set up the kind of labor administration we need, just what kind no one is hardly prepared to prescribe, which is all the more reason that we should have someone on the job developing a plan to fit the problem.

As I see the problem of industrial relations—which is nothing more than the relations between employer and employee—at the present time the fundamental basis is wages. Some pioneering, however, must be done if we are to take a leaf out of the book of experience on merchandising and profit by it. I refer now to the principle that the best can only be purchased by paying for it. That is to say, the best labor can only be bought and held with a top wage scale. Every day I am becoming more and more convinced of the soundness of the principle that high wages plus efficient management gives minimum unit production costs.

Now who is to do all this pioneering and the selling of these new ideas? It is the opportunity of a life time for the personnel manager.

The program which we have just outlined would seem sufficient to keep most any personnel department completely engaged and profitably so, under the present order of things, and it is questionable if a single part of it can be considered as non-essential. So let management preserve its newest member, personnel management; and let personnel managers be sensible of and qualified for their many responsibilities.

Engineering profession *62: 331.71*

What Engineering May Accomplish

By PAUL KREUZPOINTNER

WITH the praiseworthy desire of the engineering fraternities to step out of their professional isolation and identify themselves with the social-economic interests of the community, the question will naturally be asked—How can this desirable aim be accomplished? The ideal of management engineering is practical participation in the social life of the community along economic lines, and such participation involves social service. But social service not only demands willingness of participation in the adjustment and adaptation of forces to the social-economic welfare of the community, state, and nation, but it also involves exposure of the participator to the force of public opinion, which is seldom sufficiently well informed on economic question to be a good judge.

Anyone familiar with the relation between the engineer and the people, especially the mass of the workingmen, knows that the difference in manners and education between the two has tended to create a lack of interest, if not positive antagonism, between them which will take time and patience to overcome. This phase of the situation will be a touchstone of the ability and professional skill of management engineering.

Social Forces At Work

Increase in density of population tends to the concentration of social and economic forces, with consequent centralization of power. On the other hand, specialization in occupations and the diversity of interests of different social groups tend to the dispersion and decentralization of concentrated power, with consequent endless and conflicting diversity of public opinion about the social needs of the hour. This decentralization is a formidable obstacle towards realizing the ideal of engineering that has been expressed in the preamble of the Constitution of The Federated American Engineering Societies—"a comprehensive organization dedicated to the service of the community, state, and nation."

However laudable the idea and admirable the concept of social service by the engineers, nevertheless their efforts will fall short of their expectations unless an idea expressing the social-economic needs and the moral concept of responsibility of citizenship is accepted by the mass of the people.

The Idea Which Has a Chance

The idea which appears to have the best chance of national recognition under the law of the survival of the fittest has a double aspect: the material and the educational necessities of all the people. The latter part includes the ethical aspect of life and citizenship.

Since democracy teaches the principle of political equality, this principle has always meant to the masses in a democracy mental and physical equality of the individual citizen. They conclude that, if the individual citizen can be trusted to judge rightly of the abilities of the representatives who are to manage the affairs of government, there is no reason why he himself should not be able to manage these affairs.

This psychological trend of the general mass of men is particularly pronounced concerning the engineer and his technical and theoretical scientific knowledge. In addition to the fallacious belief that political equality is equivalent to mental equality, a variety of other causes have contributed to produce the general distrust of the engineer. The historic development of the United States, the wealth of our resources, which promoted the deceptive notion that they were inexhaustible, the inferiority of the industrial, technical, and economic training of the masses of the people or the lack of such training, the neglect of social-economic and business training in our colleges, the too frequent assumption of a mental and social superiority on the part of the engineer when dealing with workingmen, the fact that the work of the engineer necessarily and unavoidably clashed with acquired and cherished habits of wastefulness, lavishness, and carelessness of the majority of the people—all these contributed to make workers fight shy of the expert who touched the economic side of life.

Training as a Factor in Reducing Waste

How the Teaching of Correct Working Habits Will Develop Skill, Reduce Labor Turnover and Save Material

By J. F. JOHNSON

President, James F. Johnson Company

WHEN reference is made to factory waste one naturally thinks of a huge "junk" pile where various parts have been dumped because of material defects or poor workmanship. It is, of course, quite true that every plant has its "junk" pile, but besides such waste of materials, factories have other "wastes," as recent reports have disclosed, quite often more important and more easily reduced; and if some of these wastes were corrected, it would noticeably cut down the size of the "junk" pile itself.

For example, new workers require a long period of time before they "pay for their keep." Also every shop has a large percentage of those who work at their own pace, some of them far below the average of their departments; and these workers not only lose time, and lots of it, but their delay affects the whole department and lowers the standard set up by their fellow workmen.

There is also in every shop a considerable amount of carelessness, not necessarily wilful, but rather the result of bad habits contracted in the earlier stages of employment, and allowed to grow worse because of inadequate supervision. Carelessness of this type results not only in a poor quality of product but also in delays and damages to materials and equipment—matters which in themselves may not seem important but yet are found to be of considerable size when time is spent in correcting them.

Labor Turnover a Cause of Waste

Another great waste is that regularly resulting from labor turnover, when men lose interest in their work or are easily attracted to another shop—and the latter reason is not always a matter of wages. This waste represents not only a loss in the services of the man leaving but a loss of the time necessary for the new worker to become as capable as the man he replaces. Accompanying this is the consequent delay in production and the usual waste of materials.

Such are the items which too often are allowed to run on unchecked. Waste in any form is a loss and to stop such losses is the equivalent of increasing production. These wastes, of course, cannot be entirely eliminated, but if their causes be properly determined they can be reduced in large measure.

An examination of "scrap piles" in different factories has shown that a large part of the material so "junked" is due to poor workmanship. The investigation carried further has also shown that those workers whose "scrap" records were high had formed wrong working habits, acquired no doubt during the early part of their employment. The remedy for this condition has been the development of a right attitude toward the work and the forming of correct working habits based on the best known way of doing each step of the process. But as has so often been said, we have been more concerned with making products than with building up an organization and with such an objective the results that follow are quite natural. Those who were strong survived; the others dragged along, representing losses in various forms. Yet in spite of this handicap many workers rose above their surroundings.

Developing Correct Working Habits the First Step

The solution of these problems, as has been proved in various factories, is the intensive training of workers. Through such a program careless working habits can be replaced by correct working habits. Better still, by properly instructing the new worker at the beginning of his employment careless habits can be avoided.

To do this, however, requires the determination of what constitutes such correct working habits, or in other words, what is the best known manner of performing each detail of each operation. Developing new workers in these correct habits avoids in a large measure the losses in materials and time previously mentioned.

Many factories have accomplished excellent results in this direction; but more can accomplish even greater results if they will but profit by the successes—also the failures—of others. The whole process is based upon teaching and the building of habits.

In a well-known automobile factory three carloads of camshaft and crankshaft forgings were regularly carted off to the junk pile each week because of faulty workmanship. In the same plant practically 50 per cent of the crankshafts failed to pass inspection because of poor machining. There was also a large amount of other such waste, but these two are sufficient to indicate the enormous losses that were occurring; and both were due to the same cause, lack of trade ability. It was difficult, however, to expect otherwise from these men, as nothing had been done to correct their wrong practices or improve what limited ability they possessed. Later when a training department was established in this factory the operators on crankshaft work established a record of but 6 per cent spoil-

age, due to faulty machining. These men made good and their results emphasized the importance and value of proper training methods. With them the habit of working in the best manner soon became so fixed as to reduce this particular wastage to a minimum.

Another factory engaged in the making of buttons experienced machining difficulties that resulted in hundreds of gross of buttons being wasted each week. The cause of this was principally that the men did not know how to perform certain steps of their task as

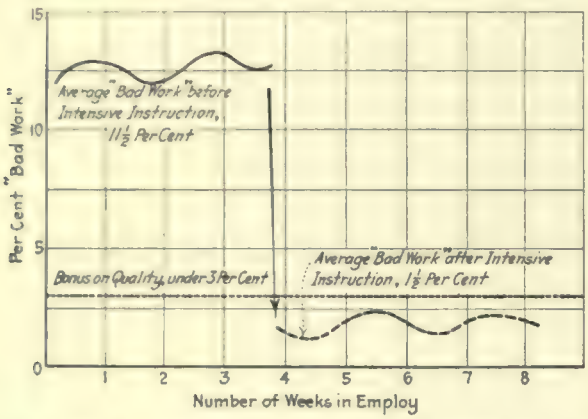
Per Cent "Bad Work"
Average "Bad Work" before Intensive Instruction, 11½ Per Cent
Bonus on Quality, under 3 Per Cent
Average "Bad Work" after Intensive Instruction, 1½ Per Cent
Number of Weeks in Employ

FIG. 1 CHART SHOWING HOW PERCENTAGE WASTAGE IS REDUCED BY INTENSIVE TRAINING OF WORKERS

well as they should. Investigation showed that those workers "producing" most waste were those who had acquired certain wrong practices in portions of their operating; these practices had "stuck" to them and the results were reflected in the percentage of work that was each day rejected.

TRAINING BENEFITS BOTH WORKER AND MANAGEMENT

Such waste in production not only lowered the average output of the department, but also showed itself in the workers' envelopes each week. How some of these carried on their daily tasks is shown by the chart of Fig. 1. The curves show the improvement of a worker engaged in turning. Before receiving any instruction the quality of his work was low, and his wastage each day so cut down his net output as to lower his weekly earnings. He also failed to profit by the attractive "quality bonus" which many of his fellow workers were enjoying. Feeling that he could not take care of his family on such wages he decided to look for more profitable employment elsewhere. After some inducement, however, he agreed to stay and accept special instruction if his boss thought that would help him. His weaknesses being determined, he was under instruction but a short time when he began to develop the right working habit. This soon became fixed and he began to show good production with very little waste. His quality improved, as shown by the chart, and his wastage continued to remain at a very low figure, so that he not only enjoyed the quality bonus, but his earnings increased nearly 60 per cent.

The effects of such a program upon the reduction of waste can be readily appreciated. The case of this particular workman has many duplicates in every shop, for the cause of such wastage will usually be found in some bad method of performing the task. Some of these wrong practices, however, do not show up until after many succeeding operations have been performed upon the piece. In a large textile factory engaged in making high-grade cotton fabric, it was found necessary to discard considerable yardage each week because the winders had failed to properly piece the ends. Poor workmanship in an early process was thus carried through the mill until the final inspection discovered it.

In investigating the methods of inducting new workers into this factory it was found that they were "turned over" to their nearest fellow worker and so the bad practices were perpetuated, growing worse as they passed from one to another. Lack of proper instruction proved to be seriously harmful in this case and when this condition was called to the attention of the overseer of the winding department and the overseer of the weaveroom both were soon strong supporters of the idea of intensive training of operators in textile mills.

THE CAUSES OF WASTE MUST BE DETERMINED

Every shop will be found to have conditions which in some manner resemble these, and valuable information can thus be secured by a careful study of defective work. This, followed up by a close observation of the

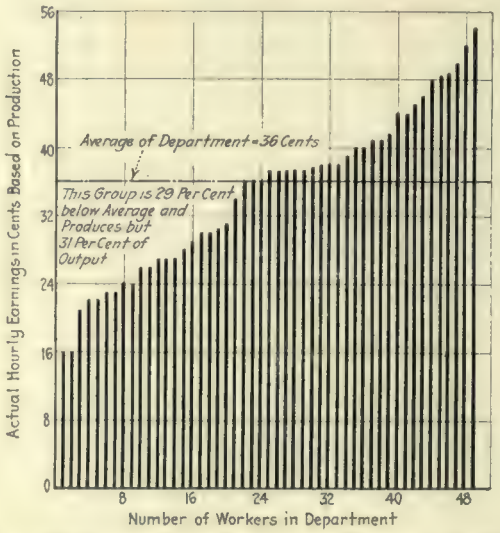
Actual Hourly Earnings in Cents Based on Production
Average of Department = 36 Cents
This Group is 29 Per Cent below Average and Produces but 31 Per Cent of Output
Number of Workers in Department

FIG. 2 AVERAGE HOURLY EARNINGS OF 49 WORKERS IN A TYPICAL FACTORY DEPARTMENT ENGAGED IN A BENCH OPERATION

various operators causing this wastage, will uncover the facts needed and will suggest the course to be taken.

Wastage through poor workmanship or through lack of sufficient trade ability can in a large measure be reduced through the medium of systematic instruction carried on according to proper training methods. This places in the hands of the management an effective remedy which not only accomplishes its particular purpose but at the same time builds up the organization.

A graphical study which gives the average hourly

earnings of a factory department will ordinarily show conditions that are indicators to other avenues of waste. Such information arranged in chart form is illustrated in Fig. 2. The data for this chart have been secured from a factory of about 800 people and it represents a department of 49 workers engaged in a bench operation. As shown, practically one-half of these workers are producing at a rate which is about 29 per cent below the average of the department; this represents but 31 per cent of the output. An investigation of this group brought out the fact that the methods of performing the task to which they were assigned upon employment were largely left to each operator

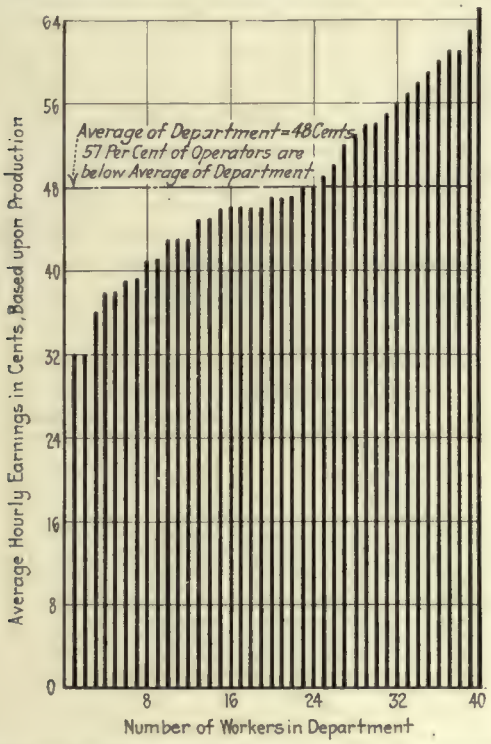

FIG. 3 AVERAGE HOURLY EARNINGS OF 40 WORKERS IN A TYPICAL FACTORY DEPARTMENT ENGAGED IN A MACHINE OPERATION

himself, and the result of this lack of a standardized method was that each operator did as well as he could, his main idea being to get his job done.

New workers entering the department would be assigned to their bench by their foreman and asked to "look at" the nearby operator doing the job. As a rule, this constituted their instruction, and after a period of "lookings" they were told to "go ahead and do it the way he did." This condition had been running on for some time and at the time this graphical study was taken practically one-third of the entire department was still failing to "earn their keep." The company, however, continued to carry them along for a certain period with the hope that what investment had been made would not be lost.

IMPROPER TRAINING WILL INCREASE WASTE

The cause of these workers failing to reach a paying basis at an earlier stage was due principally to the fact that they received little or no instruction in their job. Instead of endeavoring to have each operator do each step of his work in a manner that would enable him to obtain both quantity and quality production in the shortest time, they were allowed "to wander," so to speak, and to pick up what they could. This condition is in sharp contrast with what later took place when new workers for this department were placed under a trained instructor and developed according to proper training methods. In about two weeks this group reached production requirements and they continued to progress, turning out a high quality of work.

Fig. 3 is based upon data from a factory of about 600 workers and represents a machine operation in a department of about 40 workers. The story this chart tells is much the same as Fig. 2, though slightly varying. Both, however, are typical of ordinary factory conditions. In this particular department new workers were assigned to the foreman "to instruct." He already had a much overcrowded program of routine duties and could not give time to his new job even though he were capable of instructing. The usual practice of turning it over to "some of his men" was the result, and the new worker was made the victim.

WRONG TRAINING METHODS DELAY PRODUCTION

In such cases it took about 12 weeks for these operators to be classed as "safe." Their progress after this was very gradual and they soon found themselves in that large group that continually remained below the average. Being self-taught their manner of doing the task was far from correct, but the habit had become fixed upon them and it was natural for them to plod along under the self-imposed handicap. Workers now entering this department are able to reach production in from four to five weeks. A program of graded instruction has been worked out, and it is under the direction of a former worker who himself has been trained how to teach.

Such conditions are duplicated in most factories and they indicate the enormous amount of time being wasted in assigning operators to jobs without first thoroughly training them. It must be remembered that new workers are an expense until their earnings through actual production at least equal the wage they are being paid. To allow such time to drag on is much the same as delaying production or even adding waste to the scrap pile. Strangely enough, however, some managers feel that they are doing very well in this regard when they assign such an important function to their foremen, who no doubt already have more than they can handle effectively. They forget that foremen are neither qualified nor trained in teaching methods. Such managers do not always appreciate a loss of this kind.

Judging from training programs in operation in various factories, it is also safe to say that under right training methods results can be accomplished in one-third the time usually taken. This represents an enormous saving in time and money when one considers the

number of new workers that are taken on each year.

Where there is no proper example to imitate, however, it is questionable whether an operator can make himself very efficient within a reasonable time. On the other hand, under the influence of proper instruction, he will acquire those various habits that mark the most capable workers in a comparatively short time.

TRAINING OF WORKERS WILL INCREASE PRODUCTION

Of the different branches of industry that have made noticeable progress in shortening the training period

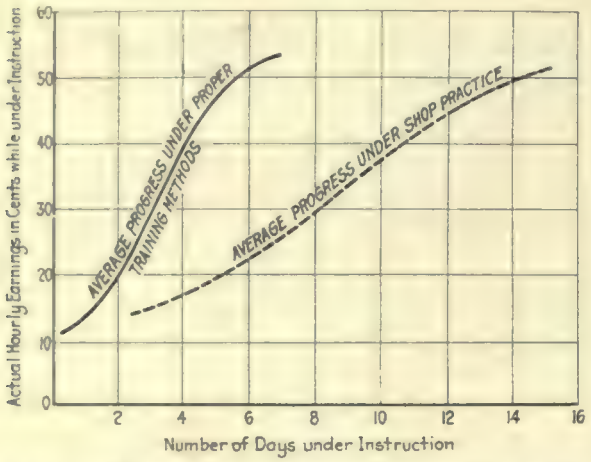
Actual Hourly Earnings in Cents while under Instruction
Number of Days under Instruction
AVERAGE PROGRESS UNDER PROPER TRAINING METHODS
AVERAGE PROGRESS UNDER SHOP PRACTICE

FIG. 4 CURVES SHOWING HOW INTENSIVE TRAINING OF WORKERS IN THE METAL TRADES HAS RESULTED IN A SAVING OF APPROXIMATELY 66 PER CENT OF THE TIME REQUIRED TO REACH AVERAGE EARNINGS

of new workers the metal working trades and the needle trades furnish the best examples. Accomplishments in these trades arranged in percentage form are shown in Figs. 4 and 5. These are composite charts and furnish comparison between the usual shop practice and the result when proper training methods are followed.

Savings of this type also are the direct equivalent of increasing production, lowering the unit labor cost, or of reducing the wastage of the junk pile. They are also indicative of a waste that continually takes place in those factories that bring up their workmen according to practices which have long ago been declared obsolete.

For the plant that takes on 1,000 workers a year at a cost of $75 per worker, training is an item that is worthy of consideration, for a direct saving of $50,000 a year, aside from the benefits to good organization, is the equivalent of the profits on much production.

Referring again to the charts of Figs. 2 and 3, which show the graphical study of a factory department and singling out those who are below the average and investigating the manner in which they work, one will easily find the reason for this particular condition. These are below average because they do not perform the details of their task in the most advisable manner. Their constant variation has led to wrong practices, which now show themselves in carelessness or that peculiar "shop gait" that so noticeably brands the workman as inferior.

This condition, however, is nothing more than the result of a thoughtless policy so often followed by some well meaning managers in placing new workers on the job. These workers are seldom instructed in their task, and nothing is done to aid them in acquiring the habits of skill and dexterity so necessary if they are to amount to anything in their class. Instead they gain what knowledge they can through their own efforts; and where ambition is not strong or the interest is lacking, the net result is what we now place below the line marked "average."

This manner of using, or rather failing to use, available talent is a serious indictment. It is the cause of an enormous loss. Yet there is no reason why this condition should continue when an effective remedy has been found for it. When such wastes as these are occurring all about them, it is not at all alarming that the workmen themselves "catch the germ."

INSTRUCTING THE WORKER REDUCES LABOR TURNOVER

While there are possibly many reasons why workers quit their jobs, it is reasonable to say that those most common indicate that they either did not like their new

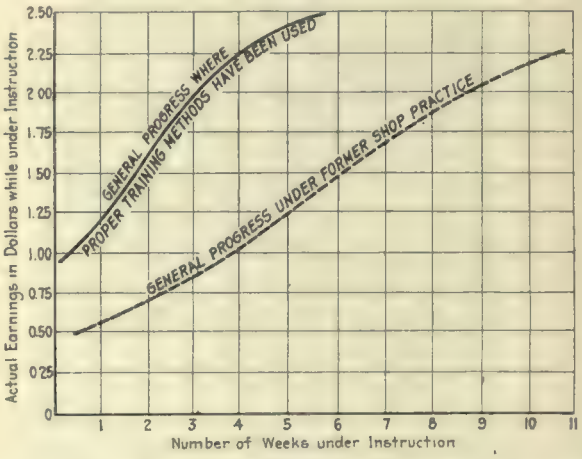
Actual Earnings in Dollars while under Instruction
Number of Weeks under Instruction
GENERAL PROGRESS WHERE PROPER TRAINING METHODS HAVE BEEN USED
GENERAL PROGRESS UNDER FORMER SHOP PRACTICE

FIG. 5 CURVES SHOWING HOW INTENSIVE TRAINING OF WORKERS IN THE NEEDLE TRADES HAS RESULTED IN A SAVING OF APPROXIMATELY 60 PER CENT IN THE TIME REQUIRED TO REACH AVERAGE EARNINGS

place or had something better in view. And where the bulk of such quitting occurs in the first few weeks of service, it is also very probable that the worker has not had time to form a correct impression of his job and its opportunities. His interest had not been aroused, neither had his ambition been appealed to; and not being attracted at the beginning, he did not remain long. Where these two factors are not recognized and directed, a very important asset is neglected.

Men's interests and ambitions can be reached when brought under the right influence. In factories where training methods have been installed the results obtained through this source have emphasized the importance of considering, when training workers, other matters aside from trade skill. Where all new employees are required to go through the training department, turnover records show a marked improvement.

Proper instruction will also develop in such employees a right attitude toward the job and the employer, arouse their ambition, and so direct their interest that they will see the opportunities before them and will have no thought of leaving. This feature of the training has proved the best preventive of a high turnover, and accomplishes its purpose with the least expenditure of effort.

The workers put through this brief period of training feel quite at home when they go to their jobs. The fact that they do well when they actually begin work greatly encourages them. And having been supervised until they developed right working habits they quickly show progress and soon fit in with the rest of the organization. It has proved a real insurance for contentment among workers.

It is commonly felt that if a new employee weathers out the first few weeks the probability of his remaining is strong. When such a period can be segregated to the training room and placed under most helpful influence, it greatly reduces the number of "leavings," besides saving the factory department from much constant interruption. How this has worked out in a factory operating under such conditions is shown in Fig. 6. The sudden change in "dropping out" of new workers may well be interpreted as an improvement in their attitude. Turnover wastes of this sort have been greatly reduced through this medium.

THE POSSIBILITIES OF TRAINING

The possibilities of systematic factory training are becoming more and more apparent as workers who are developed under its methods find their places upon the factory floor. While some managers are content to use

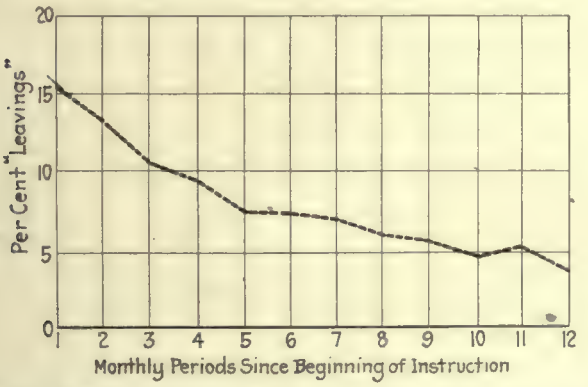

FIG. 6 A CHART SHOWING REDUCTION IN PERCENTAGE LEAVINGS WHERE NEW EMPLOYEES ARE CLEARED THROUGH AN ORGANIZED TRAINING DEPARTMENT

it as a "fill in" to train operators quickly, that they may increase their output, others analyze conditions more carefully and direct its powers toward decreasing unit labor costs. Some, realizing their losses in wastes of various kinds, use it in correcting these conditions. Others, appreciating the value of sound organization methods, develop capable workmen, improve those of their present force that need it, correct the ways of the faulty, and develop a right attitude, thus making a rounded workman rather than a mere fixture.

And the benefits of such a program are not at all one-sided. Most workers profit by the improvement in habit, and the resultant change as it affects the weekly pay envelope always has its favorable reaction. Yet factory training while young must be fostered in a helpful way if it is to develop for the good of all. The carelessness that is sometimes exhibited in rushing into this work with men not at all prepared to handle it proves a serious setback. It is merely another type of waste attempting to cover up a second waste.

Managers who would instal training in their factory must appreciate the need for sufficiently training those men whom they select as instructors under such a program. Method in training is a new matter to these people, and the results they obtain can only be in proportion to their understanding and use of these fundamentals. Their handicap is quickly reflected in those who come under their influence. The big feature of developing and fixing correct working habits is lost sight of and the program becomes nothing more than a makeshift for past practices. Workers cannot profit by such experience. The net results are always below what they should be—and it is not long before one hears that such training plans are no better than the old-time process.

Industrial efficiency *658.5*

Six Ways of Increasing Production

By G. D. HALSEY

OUR greatest need today is for more production at a lower cost, and one of the best ways to study the problem is to consider, one by one, the methods that have been used to increase production in the past, and as each is reviewed to see if it offers any additional possibilities.

The first of these methods is the introduction of labor-saving machinery; and although it has often been said that the possibility of further increase in production by the introduction of better machinery is practically exhausted, this is not true, for the use of high-priced automatic machines is by no means the only way to increase output. It is entirely possible, that by making some very small change in some jig or fixture, considerably more work can be done. With this fact in mind consider, for a moment, how the use of labor-saving machinery may increase production in your own department; and as you do so, write down in the first column of the table on the page following the percentage of perfection you consider has already been attained. For example, write down 80 per cent if you think there is room for a 20 per cent improvement. After you have done this write out in the space provided, some very definite specific things that can be done to increase production by this method.

The second method of increasing production is through specialization. It was only a few years ago that almost every manufacturing industry made a variety of goods. Today, however, one very large factory will make nothing but eyelets for shoes, and

another nothing but tin cans of one general size and style. The object of this is, of course, to make it possible to turn out parts in larger lots; for it is obvious that if the little shoeshop in the village tried to make the eyelets it used they would cost a great deal, while the specialized factory turning out very large quantities by automatic machinery will make the eyelets at one hundredth the cost. It is a well-known fact that, within reasonable limits, the larger number of pieces that can be run through in a lot the less each piece will cost.

METHODS OF INCREASING PRODUCTION	PER CENT. EFFICIENT	DEFINITE SUGGESTIONS FOR IMPROVEMENT
1. Introduction of Labor-Saving Machinery.....		
2. Specialization.....		
3. Aggregation (combination with any other department.....		
4. Standardization of Parts, etc.....		
5. Elimination of Wastes of Materials.....		
6. Increasing Individual Efficiency of Elimination of Human Wastes		

There is, however, danger in too much specialization and there have been large factories built and expensive machinery bought to manufacture one article, and suddenly the demand for that article has ceased, thus causing failure of the company. There is likewise a danger in having workmen too highly specialized, for there are times in every department when men who can do more than one job are in demand. Every organization must have some "all around" men, both as utility workmen and as material for assistant foremen and foremen.

With these facts in mind, consider again for a moment your own department, and write down in the table your suggestions.

INCREASING PRODUCTION BY CONSOLIDATION

The past twenty-five years have also been a period of consolidation; for the possibility of lower manufacturing and selling costs for the larger factories has caused the smaller places to combine. And yet while the consolidation of factories is more a problem of management than of foremanship, there are, nevertheless, possibilities of consolidation within almost any organization. Possibly you are doing some little job in your own department that could better be combined with the similar work in another department. Study your problem and write down your recommendation in the table above.

Not many years ago almost all machinery was built to order, and the buyer specified just what size he wished the parts to be. Today, however, most manufacturers of machinery have standardized on certain definite sizes and types and make these only; so that now it costs several times as much to build a special machine as it does to build a standard one.

Apply this method now to the work of your own department. Study your problem and see if you cannot find a place where one size or style of part will do equally as well as the two or more parts now being made. And as you do so, mark down your suggestions in the space provided in the table.

The last two methods of increasing production—elimination of waste of material and increasing individual efficiency—offers perhaps the greatest opportunity for good foremanship; because the elimination of waste, both of materials and human effort, is a problem that must be solved by the foreman, the man right on the job.

So study your department. Would a little better checking system make your men less careless in their use of rags or waste? Can you work out some scheme of inspection that will catch errors, before many pieces are spoiled? Can you suggest a plan for interesting the men in an "antiwaste" campaign? Will more systematic supervision on your part put down the spoilage of work? Write your suggestions.

INCREASING PRODUCTION BY INDIVIDUAL EFFICIENCY

The greatest increase in production will come, however, only through human effort and individual efficiency. We have spent much time and thought in developing to the highest degree labor-saving machinery, and in eliminating all waste of materials; but we have given very little thought as to the very best methods of utilizing the human power under our control. Have you ever figured, for instance, just how much it costs you to train a new man his first six weeks in your department? If not, put down your estimate in the following space:

Wages for six weeks.....
Wages of instructor.....
Additional expense of supervision.....
Cost of work spoiled above the average.....
Cost of tools broken above the average.....
Machine charge (or overhead) for the time.....
Total .....
From this should be deducted the normal labor and machine charge for product actually produced.....
Actual Net Cost.....

Now go over your records carefully and find out how many new men have quit your department in the past few months, and see how large the cost has been. Is there any way by more careful handling that you could cut down this turnover? But high turnover is by no means the only human waste. Are the men who have been with you some time putting their best into the work? Is the pay system such that it justly rewards those who give the best service? Have you good, clean drinking water and sanitary toilets? Do you watch the health of your men?

Think over carefully every phase of the human efficiency in your department, and record your suggestions. It will be worth while.

The High Cost of Idleness

By G. CHARTER HARRISON

Consulting Accountant

IN George Horace Lorimer's "A Self-Made Merchant's Letters to His Son" Old Gordon Graham remarks that to get any sense out of a proverb he generally finds it necessary to turn it wrong side out. There is little doubt that this is the process which would be applied by the industrial world today to the Italian proverb *Dolce far niente,* or "Sweet is the condition

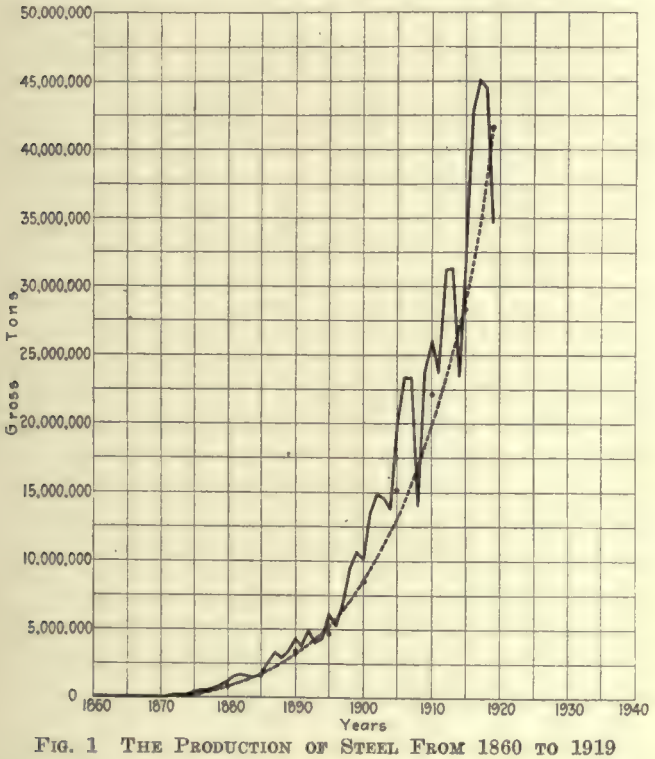

FIG. 1 THE PRODUCTION OF STEEL FROM 1860 TO 1919

of doing nothing," for there is certainly nothing pleasurable about the condition of enforced idleness from which we are now suffering.

When times are good there is a tendency on the part of the average man to believe that this happy condition will continue more or less indefinitely, and, conversely, in periods of depression he tends to swing to the other extreme and become convinced that never again will business boom—this in spite of the testimony of all history to the contrary. It is the man who some months ago was most sure that the long-heralded period of depression was a false alarm who today is the most pessimistic about the future. The trouble, of course, with him and, to some extent, with most of us is that we are lacking in perspective, and Mr. Gary sounded the right note the other day when he said:

> For I think that we shall have to revise our ideas of prosperity and look to earnings over the years rather than to the earnings of a season. . . .

When he wrote these words, Mr. Gary probably had in mind some such picture, illustrating the development of the industry with which he is identified as is shown in Fig. 1. In the figure the solid line represents the yearly production of steel in gross tons during the period from 1860 to 1919, inclusive, and the small dots represent the average yearly production by five-year periods, while the dotted line indicates what may be considered the normal curve of progression. The curves tell their own story and are an interesting commentary on Mr. Gary's suggestion that we should consider earnings over the years rather than by seasons; a study of them should afford considerable consolation to the pessimistically inclined.

Possibly in the distant future we may have sufficient control over the various factors influencing industrial affairs to be able to eliminate the peaks and valleys illustrated in the diagram, but as alternate periods of expansion and depression would appear to be inevitable under the present scheme of things it would seem to be the path of ordinary business prudence in the fat years to remember that the lean years are sure to come and from the abundant profits earned in times of prosperity to set aside sufficient to carry us over periods of depression.

Of course, it is the custom of the prudent manufacturing company to set aside out of earnings substantial amounts for the purpose of providing a reserve for contingencies, the amounts so appropriated being decided upon by the directors. The reserve the writer has in mind, however, is a specific one figured on a definitely predetermined basis, in the same manner as a reserve for depreciation of properties or for relining of furnaces. Considering that periods of business depression are as inevitable as the fact that machinery will ultimately wear out, and need to be replaced, it would seem to be logical to provide for the former as systematically as for the latter.

FIXED CHARGES SHOULD BE EQUALIZED OVER YEARS

The large profits which are made during boom times as compared with the earnings of periods of depression are due to three primary causes:

1. The higher prices realized during such periods.
2. The reduction in fixed charge costs per unit of product owing to the increased production.
3. The greater volume of sales.

Now, if we followed Mr. Gary's suggestion of considering earnings over periods of years instead of by seasons or individual years, it would be possible to eliminate largely the fluctuations in profits owing to variations in the fixed charge costs due to the peaks and valleys of production, and to equalize these charges in a manner similar to that followed by the steel manufacturer, who, instead of charging the cost of relining furnaces to the cost sheet of the month in which the

work is done sets up a reserve for this expense by charging all production at so much a ton.

In order to provide systematically for the equalization of the fixed charge expenditures, it is necessary, of course, to determine firstly what expenditures can properly be classified as fixed charges; and secondly, to predetermine the average production which may be anticipated over a term of years. The first of these requirements presents no particular difficulty, but the second demands the exercise of imagination and judgment, and, of course, involves an element of uncertainty. However, referring again to Fig. 1, it will be seen that, taking the curve for the period from 1860 to 1890, the succeeding five-year period could have been closely estimated as also that for the five years following. In any event, an estimate need by no means be considered as final, and the skilled accountant will experience no particular difficulty in modifying his original figures and making the necessary accounting adjustments to bring his statements into line with his revised estimate.

A Simple Example of the Plan

The plan suggested may be illustrated by a simple example: Assume, for instance, that the production of a business over a five-year period has been predetermined as follows:

	Units of Production
First year	100,000
Second year	105,000
Third year	110,000
Fourth year	115,000
Fifth year	120,000
Total	550,000

Assume further that the actual fixed charges and production during this five-year period result as follows:

	Production Units	Fixed Charges
First year	110,000	$100,000
Second year	115,000	105,000
Third year	120,000	110,000
Fourth year	100,000	110,000
Fifth year	100,000	105,000
Total	545,000	$530,000

Then the distribution of the fixed charges to the production and the reserve for idle time, using the predetermined production as a basis, would work out as shown by Table 1.

From the figures of this table it will be seen that in the first three years, owing to the production being in excess of the estimates, the amount of $30,000 was set aside as a reserve for future idle time, but that this amount was absorbed in the following two years of decreased production and the idle time reserve account was overdrawn at the close of the five-year period to the extent of $1,848.

Criticism may be made of the plan illustrated on the grounds that it introduces an element of uncertainty in the accounts, but as regards this it may be urged that this element of uncertainty is inherent in practically all accounting reserves—the accuracy of a reserve for bad debts is dependent upon circumstances impossible to foresee and even in the case of reserves for depreciation the element of obsolescence due to unexpected improvements may make the most careful calculation fall far short of the mark.

The Cost of Idle Time Should Be Known

One of the most encouraging features pointing to the renaissance of cost accounting is the attention given by engineers in the last year or so to the proper handling of idle time in costs. Much of the credit for this belongs to the late H. L. Gantt, who in a paper read before The American Society of Mechanical Engineers in 1915 clearly stated the case against the accepted cost methods as follows:

> There are in common use several methods of distributing this (indirect) expense. One is to distribute the total indirect expense, including interest, taxes, insurance, etc., according to the direct labor. Another is to distribute a portion of this expense according to direct labor, and a portion according to machine hours. Other methods distribute a certain amount of this expense on the material used, etc. Most of these methods contemplate the distribution of all of the indirect expense of the manufacturing plant, however much it may be, on the output produced, no matter how small it is.
>
> If the factory is running at its full, or normal, capacity, this item of indirect expense per unit of product is usually small. If the factory is running at only a fraction of its capacity, say one-half, and turning out only one-half of its normal product, there is but little change in the total amount of this indirect expense, all of which must now be distributed over half as much product as previously, each unit of product thereby being obliged to bear approximately twice as much expense as previously.
>
> When times are good, and there is plenty of business, this method of accounting indicates that our costs are low; but when times become bad and business is slack, it indicates high costs due to the increased proportion of burden each unit has to bear. During good times, when there is a demand for all the products we can make, it is usually sold at a high price and the element of cost is not such an important factor. When business is dull, however, we cannot get such a high price for our product, and the question of how low a price we can afford to sell the product at is of vital importance. Our cost systems, as generally operated at present, show under such conditions that our costs are high, and if business is very bad they usually show us a cost far greater than the amount we can get for the goods. In other words, our present systems of cost accounting go to pieces when they are most needed. This being the case, many of us have felt for a long time that there was something radically wrong with the present theories on the subject.

Most manufacturers in these days of business depression will appreciate the truth of Mr. Gantt's dictum that cost systems which do not distinguish between the cost of idleness and the cost of production "go to pieces when they are most needed" and where such systems are in force it will be found that the sales managers frankly admit that in setting prices they ignore the figures emanating from the cost department. In times of reduced production, such cost systems tend to create a vicious circle since, owing to the high fixed charge cost per unit of production, prices based on the cost figures are too high to meet competition and since quotations based on these costs do not obtain orders production is still further decreased with a corresponding increase in costs. Furthermore, the practice of charging the cost of idle equipment to production results in inflated inventories and in the payment of

taxes in one year on profits not really earned. Even though such overvaluation of inventories will result in reducing the profits of succeeding years, no manufacturer in these days of depleted bank balances is anxious to pay taxes a year ahead.

As illustrating the dangers of blind adherence to cost figures as a basis for setting selling prices the writer may perhaps be pardoned for referring to a recent personal experience. A month or so ago in a small town of upper New York State he had occasion to price some furniture for a summer cottage and, noting a difference of several dollars between two lots of linoleum rugs made by the same concern and of apparently the same quality, inquired as to the reason. The saleslady was very frank about it and stated that last year's patterns would cost three dollars more than this year's owing to the fact that the store had paid this amount more for the goods than for the new stock, though, if anything, this year's goods were superior to those purchased last year. Furthermore, she seemed to consider the writer very dense because he could not see the justice of this arrangement. At another store he inquired the price of a chisel and asked whether this was based on the current price scale; again he was told that this would depend upon when the goods were purchased, because, as the salesman put it, "if we purchased the goods on a war-basis price we will have to charge you on that basis." Though these incidents may appear ludicrous it may be fairly stated that many of the arguments of the average cost man are based on foundations of a similar character.

TABLE 1. DISTRIBUTION OF FIXED CHARGES.

YEAR	STANDARD PRODUCTION	ACTUAL PRODUCTION	TOTAL FIXED CHARGES	FIXED CHARGE COST PER UNIT OF STANDARD PRODUCTION	DISTRIBUTION OF FIXED CHARGES	
					PRODUCTION	IDLE TIME RESERVE
1	100,000	110,000	$100,000	$1.00	$110,000	$10,000
2	105,000	115,000	105,000	1.00	115,000	10,000
3	110,000	120,000	110,000	1.00	120,000	10,000
4	115,000	100,000	110,000	0.956	95,652	14,348
5	120,000	100,000	105,000	0.875	87,500	*17,500*
	550,000	545,000	$530,000		$528,152	*$1,848*

Italic figures indicate debit.

PROPER ACCOUNTING METHODS NECESSARY

In a previous article by the writer[1] the statement was made, that the basic trouble with cost accounting is that it is unscientific, and that cost accounting "which does not consider costs in relation to standards and is not concerned with determining the causes underlying cost variations is hopelessly at variance with the prospective trend of modern industrial thought." The fact that under the great majority of cost systems idle time expense is still distributed to production would seem to substantiate this statement, for under a scientific system of cost accounting which provides for the determination of the causes underlying cost variations (and no system of cost accounting has any claim to being considered scientific which does not provide for such an analysis) the cost of idle time is inevitably disclosed. This will be obvious if we consider a simple illustration.

Assume, for instance, that the fixed charges of a factory are $10,000 a month and that the charges for producing labor when operating at full capacity are $100,000 a month. It is obvious then that the standard burden rate for fixed charges per dollar of standard labor is 10 cents. But in the event that the factory is operating at only 50 per cent of normal, and that its producing labor is accordingly reduced to $50,000 a month, if the fixed charges are distributed over the production for the month the actual rate per dollar of producing labor will be 20 cents instead of 10 cents. A comparison of actual and standard will then be as follows:

Actual fixed charge expense for month.....	$10,000
Standard fixed charge cost of production—$.10 per dollar on $50,000 producing labor...	5,000
Excess of actual cost over standard.....	$ 5,000

The actual expenditure for fixed charges is the same as standard, the only variation from standard being in the production, so that the increase of $5,000 over standard shown above is obviously due to this cause and is a proper charge to idle time.

It is perfectly possible to sell goods at less than cost (*including* fixed charges) and still make an ultimate profit on the sale, and it is this fact which makes so important the provision for distinguishing the cost of idleness from the cost of production in the accounts. This will be obvious if we consider the illustration just given. If this factory, for example, should obtain sufficient additional sales at actual cost (*including* the standard fixed charge cost of 10 cents) to bring its production up to normal, it would realize an increase in profits to the extent of that proportion of the fixed charges which otherwise would require to be absorbed by the reduced production. In other words by making these additional sales at actual cost (*including* fixed charges) the profits would be increased $5,000. It may therefore be stated that when a factory is operating at less than normal capacity any additional sales made at prices in excess of cost (*including* fixed charges) will result in additional profits or reduced losses to the extent of this excess.

Of course the decision as to whether idle time expense should be provided for by reserves in the manner previously suggested or should be charged direct to the profit and loss account of the month in which the loss is incurred does not lie with the accountant *per se* but with the management of the business. It is, however, distinctly the responsibility of the accountant to advise the executives as to the amount of loss due to this cause.

[1] See MANAGEMENT ENGINEERING for July, 1921, p. 29.

There is all the difference in the world between knowing in a general way that decreased production means high costs and having definite information each month as to the exact loss due to this decreased production. Furthermore, the sales manager who knows exactly at what point he can sell goods and still make a profit, owing to the absorption of fixed charges which otherwise would be a charge to the idle time account, is in an immensely stronger position than his competitor who is acting in the dark. It is probably no exaggeration to say that at least 50 per cent of the manufacturing concerns in this country today do not know at what point profits cease and losses begin, and this condition of affairs is due to the absurd accounting fallacy referred to by Mr. Gantt in the quotation previously given, namely, that the indirect expenses of a manufacturing plant, however much they may be, must be distributed to the output produced, however small it may be.

THE ACCOUNTANT A GUIDE FOR THE SALES MANAGER

Of course, in depressed times like the present, when owing to lack of orders the average factory is probably operating at less than 60 per cent of normal capacity, the factor of production efficiency, whatever effect it may have on direct costs, has little bearing on indirect expenses. With machines lying idle for want of orders, and operators waiting at the gate for an opportunity to work, loss of production owing to the inefficiency of operators can be made up by hiring additional help and placing idle machines in operation. The situation, however, is changed entirely when a factory has sufficient work ahead to keep all departments working at full capacity, for then the inefficiency of operators has a very direct bearing on the indirect expenses. Under these conditions it is necessary that the accountant should furnish the factory manager with an analysis of the losses due to decreased production, so that he may know how much of this expense was due to machines actually being shut down, whether due to lack of operators, material, or tools, or to breakdowns; how much owing to the production of the machine when actually operating and its production less than standard, and how much due to lack of orders for certain machines.

Though fluctuation in costs owing to idle time is probably the most important single item of cost variation it should be noted that a system of cost accounting should provide for the determination and analysis of cost variations by all causes. The methods required for the analysis of idle time expense are so intimately bound up with those requisite for the determination and analysis of other variations from standard that an understanding of these methods would involve a discussion of the whole theory of cost variations.

It may be stated, however, that when a cost system provides for comparisons of all costs with standards and for an analysis of variations from standard, according to the causes contributing to these variations, then and then only does cost accounting emerge from its previous empirical status and become justified in its claim to be considered a science. When this is accomplished, cost accounting will become a constructive force and the cost accountant will take his proper place in the ranks of industry.

Machinery. Factory layout *621.711*

Scene Shifting in a Manufacturing Plant

By L. V. ESTES

President, L. V. Estes, Inc.

EVERY engineer knows that it is common practice to transfer the application of a basic idea from one industry to another, and this interchange of principles and methods is quite frequently seen in the application of certain mechanical principles. Take, for example, the Ferris-wheel principle. This has been applied to the painting of small castings where it is used for dipping and drying; to the gluing of lumber for panel stock; to the drying of textile products such as hosiery, and to the baking of bread and crackers. There is also the foundry tumbling barrel idea, which is in use in a collar factory for shaping collars. And so it goes. Probably, however, the most common examples of this practice are in the field of material handling; in fact the application of material handling principles are so broad that we now have engineers devoted exclusively to applying these principles in all kinds of industries.

THE SCENE-SHIFTING PRINCIPLE

One principle, however, which as yet has not been sufficiently developed in its application to industry is that of scene shifting as in a play. The application of this idea to industry would result in the moving about of equipment and machinery to meet the ever-changing operation requirements of the product as it takes a direct course through the plant. This idea is not new, but its general application is. Take, for example, the steam shovel, the portable logging saw, the portable welding plant for rail welding or the various portable tools used in ship-building. In all of these the principle is applied because it is obviously necessary to do so. The saw must be taken to the tree because the tree cannot be brought to the saw.

It seems to me that industry is full of such instances where the scene-shifting principle can be applied. The need may not be so obvious as in the case of the logging saw, but savings would accrue that would make the adoption of the plan fully justified.

The scene-shifting idea, like many other good ideas, has never been tried out to any extent in industry simply because it takes planning—thinking it out and working it out in advance. It is like the planning of production, and industry formerly never bothered much with production planning because it required thinking—and trained scientific minds, at that—to do the thinking.

I have in mind an experiment which I made along these lines, of shifting the machines to provide a direct straight-line flow of production in a plant producing, among other things, automobile motor oil pans from sheet steel. The situation was complicated because it was also necessary to use the machinery for both special and jobbing work.

At this writing the plan has not been carried to completion, mainly because of the vastly curtailed operation of the plant, but the experience to date is valuable in that it has brought out the many variables to be dealt with as well as ways and means for handling and controlling them.

AN APPLICATION OF THE PRINCIPLE

The plant to which I refer manufactures 25 different styles of automobile oil pans. The operations on each, although of a similar nature, varied from 8 to 35 according to style of pan. The runs were fairly long, being of two or three days' and sometimes of a week's duration, and as previously stated there were also special and jobbing work going through at the same time. The problem presented therefore was: How could the machinery of this department be used to accomplish in consecutive order the operations on all of these parts, each of which had a different operation sequence?

The accomplishment of this object would, of course, eliminate the great amount of material-handling that would be necessary under any arrangement that could be devised with stationary equipment. The manufacturer's own organization had already spent considerable time in trying to arrive at a satisfactory stationary machine layout. They had made department layouts in every conceivable form: circular, square, triangular, rectangular, and wing arrangements, but they did not find a solution of the problem that they felt was satisfactory.

There was no stationary machine arrangement that would give a straight-line flow of production because it was necessary in many instances to perform by means of one machine several operations on a part, and these operations would not be in sequence. For instance, a part having eight operations would have the first, fifth, and eighth done on one machine. The material would travel about the department for operations two, three, four, six and seven, but two return trips to the first machine would be necessary for operations five and eight.

THREE VARIABLES MUST FIRST BE ANALYZED

In our attack on these problems, an analysis was first made to determine what the variables were that controlled the application of the scene-shifting idea. These were found to be of three general classes, namely:

1. Those due to the product.
2. Those due to the machine equipment.
3. Those due to manufacturing requirements and operating conditions.

Under the first general heading would come such variables as:

(*a*) Size of parts or units handled.
(*b*) Weight.
(*c*) Bulk.
(*d*) Size of trucking unit.
(*e*) Quantity in a lot.
(*f*) Fixity of product.

By "size of trucking unit" is meant the quantity handled and trucked about as a unit, as for instance the handling of small parts in tote boxes as against the handling of very large castings by trucks or cranes.

"Fixity of product" refers to the weight of the product and the ease or difficulty with which it can be moved, examples being very large castings or ships in drydock.

As before stated, the problem presented was concerned with the manufacture of sheet steel oil pans. These were fairly heavy and were run through in large lots that were bulky and took up floor space. It can readily be seen, therefore, that the constant trucking and back-trucking from machine to machine is quite a problem with a product of this nature.

MACHINE EQUIPMENT A FACTOR TO BE CONSIDERED

Under the second general head, "Variables due to machine equipment," come such variables as:

(*a*) Size and weight of machine.
(*b*) Precision required of machines.
(*c*) Machine foundations.
(*d*) Power and other machine service.

It is obvious that it would not pay to move large machines about except, of course, where the product is fixed. It is also not practical to move continually machines that require a true alignment because of the precise nature of the work.

The matter of drive, belting, gas supply for welding, electricity, water for cooling, soda water, oil, etc., presents many problems, and the plant to which I refer required that such a problem be solved. There were both heavy and light machines, but the work did not require a degree of precision that prevented a moving about of the lighter types.

The plan evolved for moving the machines was to equip them with wheels provided with an adjustable lift arrangement somewhat similar to the mechanism of a lift truck. By this means the wheels could be used for moving the machines about and they could be lowered to rest on the floor while in use.

Machine service presented a serious problem because the operations performed were chiefly spot welding, gas welding, drilling, tapping, punching, brazing, re-tapping, straightening, and gauging. The machines were motor-driven and it was necessary, therefore, to provide, also, connections for water, gas, and electricity at all places where the various machines requiring these services were to be used.

In order to determine where electric, gas, water and drainage connections could be made at least expense it was first of all necessary to know in which position the machines would be used under all conditions and the placing of these various service connections thus involved a complete study of the routing of all parts

worked on. It required floor plans showing set-up locations for machines for each different class of jobs and also an analysis of all such floor plans to determine the positions in which machines would be set the greatest number of times during a complete run of all kinds of motor oil pans. For jobbing, work combinations of set-ups from the standard production would be used.

PRODUCTION CONTROL MUST BE CAREFULLY STUDIED

Under the third general heading "Variables due to manufacturing requirements and operating conditions" there appear such variables as:

(*a*) Scheduled time allowed for job runs.
(*b*) Quantity of work ahead.
(*c*) Repeat operations.
(*d*) Extent of defective work—cripples.
(*e*) Building, floor space, and other limitations.

Here we come to the place where the scene-shifting plan must meet the requirements of the production control plan and work in with it, for it is not only necessary to schedule and flow the work in process, but it is necessary also to schedule the machines so that they will be at the right place at the right time.

By this plan machine placement must be anticipated and a standard placement schedule prepared for the use of department heads and planning clerks. In the same way that production is planned ahead for two or three days or perhaps a whole month, so the shifting of machinery must be planned and standard instructions issued sufficiently in advance to permit all jobs to be accommodated.

This planning of machine placement must take into consideration that a job passing through a department is not completed all at once, but may be strung out along a number of machines. The question involved is, at what times during the movement of a job through a department can the various machines be moved so as to be ready for the next job?

When the machines are in place ready for the job, the material, tools, drawings, and instruction sheets must also be ready. The patrolling supervisor should likewise be on hand to see that machines are placed on schedule and that the placement schedule is meeting the requirements of the production schedule.

The matter of repeat operations has already been referred to as a difficulty to be handled. This is where a part leaves a machine and comes back to it again, possibly two or three times. After a complete analysis is made it may pay to put in a few additional machines at points where the need is great. In the plant to which I refer straight-line work predominated.

THE DIFFICULTY OF REPEAT OPERATION

The matter of defective work and return of crippled parts for repairs was one of the greatest difficulties we had to overcome. In many cases the crippled part was not detected until it had reached several machines beyond the one where it was made defective and the machine that caused it had in the meantime been reset and begun work on another job. Crippled parts occurred, however, on only a few jobs, and in those cases reset-ups might be necessary, but the total cost of resets was small in comparison with savings made.

Building limitations, floor space, and other factors enter into a consideration of the scene-shifting plan. They may in some cases be a deciding factor. In the case in point, however, the plant was new and there were no limitations due to these causes.

There are difficulties, of course, in the adoption of a scene-shifting plan and in some cases the analysis of variables will undoubtedly indicate that the plan will not apply. I have tried to show what these variables are so that anyone else can make the same analysis; others may think about the idea and possibly carry it along further. I am convinced that there are thousands of manufacturing plants in this country that could well profit by a study of this idea.

There must be numerous cases in the experience of readers where this plan has been tried out in whole or in part. My hope is that this article may bring forth a discussion that will lead to a constructive development of a subject which appears to me to contain great possibilities.

Management engineering 658

A Definition of Management

At the organization meeting of the Management Division of The American Society of Mechanical Engineers, held in July, 1920, a request was made for a definition of management, and for a statement of the object or purpose of the newly organized functional group of the Society. The Executive Committee of the Division met these requests in its annual report, as follows:

"The first sentence of the preamble of the constitution of The Federated American Engineering Societies presents a definition of management as a part of a broad definition of engineering, and taking that concept and expanding the language in which it was expressed, we have this definition of management itself:

> "Management is the art and science of preparing, organizing and directing human effort applied to control the forces and to utilize the materials of nature for the benefit of man.

"An interpretation of this definition amid the present needs of engineering and industry brings the belief that dissemination of the knowledge of management will increase and enlarge the many benefits which applied science has already brought to the human race, and thus it leads us to the following statement of the purpose or object of the Management Division:

"Inasmuch as the problems of management are of the utmost complexity and difficulty, the Management Division of The American Society of Mechanical Engineers in seeking to render disinterested service, therefore declares its purpose to be the formulation and declaration of the fundamentals of management, both regulative principles and accepted practice, and the dissemination of management knowledge.

"Standard Time" in Planning and Production

How It Is Utilized to Eliminate Delays, Estimate Output and Compare Results of Machine and Department Operation

By WALDO LYON

Directing Engineer, James E. Morrison Company

THE establishing of standard time for the performance of the many operations necessary to produce the complete product of the average manufacturing plant is by no means an insignificant task. The man qualified to establish a standard time for the performance of an operation must necessarily be a man of experience, a trained observer, and one possessed of sound judgment. He cannot afford to miss the slightest detail connected with the work, and he must study carefully not only the operator performing the work, but also the tools and equipment used.

Furthermore, if he fails in any of the details, he has not established a standard time, for there is no such thing as an improper standard time. Clerks with no other qualifications for setting standards than the possession of a stop-watch and lead-pencil can be found in a great many cases attempting to set standards for work performance, but far better results would be obtained if the operator were placed on his honor and left to establish the standards himself. This is not, however, a discussion of the methods involved in establishing standard times, but of the benefits derived from the standards once they have been established.

Standard Time the Basis of Wage Payment

Perhaps standard time is most generally used as a basis of wage payment for labor performed; and while in some cases it is still maintained that the basic day or hourly rate of pay produces the best results, the consensus of opinion now takes the opposite view, namely, that labor should be paid in accordance with the results produced. The argument put forth by the opponents of the standard time system is that the worker who strives for quantity will secure it at the expense of quality. This, however, to a large extent is a fallacy, for the reason that the incentive form of pay if properly applied will protect quality by imposing a penalty for poor workmanship.

But even without this protection the question as to whether quality suffers under the incentive form of pay is at least debatable. Anyone who has ever worked under the two methods, or who has supervised others so working, will agree that the mental state of the worker undergoes a remarkable change when transferred from a day-rate system to a system based on standard time.

The average worker on day work of a routine nature becomes sluggish, time drags, and he is anxious only for the closing hour. In this state of mind the worker becomes careless and his work suffers accordingly. On the other hand, to the man receiving an incentive form of pay, time often seems to pass all too swiftly; he is keen and alert, and his hand and eye work in perfect unison. He is continually trying to improve the methods of performing his work, and while in this state of mind it is very doubtful if quality suffers.

Standard Time Aids in Eliminating Delays

But whatever incentive form of pay is used, whether it be piecework, bonus, or premium time, it must be based on standard time to obtain real results. Furthermore, there is no doubt that as a definite knowledge upon which to base the rate of pay for work performed, the possession of standard times is well worth the cost involved in establishing the standards. But just why so many are apparently content to stop at this point after going to this expense is hard to understand.

This inclination to disregard standard time seems to be most common among those using the piecework form of payment. The reasons for this apparently are, first, that the dollar is used as a standard rather than the hour, and, second, the notion that piecework cannot be readily applied to miscellaneous work. This latter idea applies also to the 100 per cent time premium plan.

It would seem that in those plants where the Emerson or Morrison form of bonus is employed the use of standard time has been carried further and with much better results than in those plants using other forms of wage payment. The fact that these two forms of payment can be easily applied to every employee and activity in the plant is a distinct advantage, and where miscellaneous work is of considerable importance they may assist in eliminating the delays that bear so heavily upon production.

One example that the writer recalls showing how a bonus led to the elimination of delay, was that of a foundry where the common labor was placed on bonus for the purpose of eliminating delays in the productive operations. While the form of application in this instance might be questioned, chiefly because no definite measure of determining the efficiency of the worker was provided, yet without doubt the bonus helped the moulders increase their output, and certainly gave the management a control over this work which was lacking before.

Another advantage of the Emerson and Morrison form of bonus is that it is computed upon the efficiency attained over a period of time (usually a pay period of one or two weeks' time) and is not based upon the per-

formance of a single job. Dependable averages, which are invaluable to the planning department, and which supply information to the management by which it is able to exercise a close control, can thus be built up.

STANDARD TIME AN AID IN PLANNING WORK

Another use made of the standard time, but one which has been much neglected and overlooked, is in the planning of work. The extent to which planning of work may be carried by the proper use of the stand-

OPERATION SHEET

Part Name Journal Box — Part No. C-1245

Type M

Date 12/10/20 Material Cast Iron Unit No. 120 — No. Required 4

OPERATION	O. P. NO.	DEPT.	MACHINE NO. 1	2	3	STD. HR'S. PER 100	RATE PER 100 PCS. MECHANIC	HELPER
Mill Face	3	M	172	174		11 50	$ 6 96	
Drill Bolt Holes	4	C	132			2 50	1 25	
Drill Oil Hole	5	C	126	127	129	50	25	

FIG. 1. OPERATION SHEET SHOWING USE OF STANDARD TIME

ard time is practically unlimited, for with the standard time marked upon an operation sheet (Fig. 1) it becomes a simple matter to determine the necessary amount of time to allow for the processing of any part through the factory.

The machine loading chart shown in Fig. 2, for example, is a great aid in loading work to a machine, inasmuch as it enables the planning department quickly to determine the time required to reduce any number of bars of metal to 0.500 or 0.300 of an inch in thickness. Let us assume that the order to be processed called for 135 bars of high spinning and drawing metal, 5 in. wide, to be reduced to 0.500 in. in thickness. Looking under this alloy and opposite the 5-in. width is found the time required for this reduction on 100 bars. This time multiplied by the number of bars on the order equals the time necessary to process (135 bars $\times$ 1.26 = 1.70 hr.).

But while this chart gives the amount that can be processed under favorable conditions at 100 per cent accomplishment, it gives no information as to how the operator is working. If the planning department were to send to the plant every day 10 hr. of work for a certain machine, and the operator of that machine was working at 50 per cent efficiency, the work would soon pile up and promises of delivery made on this basis would not be reliable.

It is evident, therefore, that before real planning can be undertaken information as to accomplishment must be available. A daily report of efficiency and delays, as shown in Fig. 3, is used in some plants to supply the planning department with this information; and this report, it will be noted, shows not only the number of standard-hours work produced by each machine, but also the per cent of efficiency and delays at which it is operating. These percentages, except in extraordinary cases, do not vary from one week to another by more than 1 or 2 per cent, and are, therefore, reliable for planning purposes.

In order to illustrate the proper planning of work let us consider Machine No. 1. Fig. 3 shows that this machine operates only 84 per cent of the time (16 per cent delay) and at an efficiency of 80 per cent. Consequently, instead of sending to this machine 10 hr. of work per 10 hr. day, 1.6 hr. (16 per cent of the 10-hr. day) should be allowed for delays. This allowance leaves 8.4 hr. as the actual running time. As the machine operates at but 80 per cent it accomplishes but 6.7 hr. work during a running time of 8.4 hr. Therefore 6.7 hr. work should be sent instead of 10.

STANDARD TIME AS A MEASURE OF PRODUCTION

The most valuable use, however, that can be made of the standard time is as a basis for measuring the accomplishment for the various departments and of the plant itself. The standard hour is the only true measure of production and the only way in which the accomplishment of one department may be compared with

LOADING CHART
Compiled for use in Scheduling Work to Brass Mill
Approximate present practice
Computed on No 1 Roll - Time shown in Hours per 100 Bars

ALLOY	HIGH SPINNING AND DRAWING		LEADED		TACK BRASS		NAVAL BRASS		RICH LOW GILDING BRONZE		PHOS. BRONZE		SILVER	
WIDTH BAR	HOURS TO 0.500	HOURS TO 0.300	HOURS TO 0.500	HOURS TO 0.300	HOURS TO 0.500	HOURS TO 0.300	HOURS TO 0.500	HOURS TO 0.300	HOURS TO 0.500	HOURS TO 0.300	HOURS TO 0.500	HOURS TO 0.300	HOURS TO 0.500	HOURS TO 0.300
3½	0.94	1.34	1.09	1.80	0.94	1.38	1.09	1.80	1.59	2.86	1.59	2.97	1.80	2.85
3¾	1.13	1.52	1.28	1.97	1.08	1.77	1.28	1.97	1.56	2.82	1.56	2.88	1.75	2.77
4	0.97	1.36	1.30	2.00	0.96	1.33	1.30	2.00	1.60	2.95	1.60	2.95	1.79	2.83
4¼	1.13	1.80	1.26	1.93	1.15	1.82	1.26	1.93	1.72	3.02	1.72	3.02	1.72	2.72
4½	1.11	1.77	1.23	2.18	1.33	2.00	1.23	2.18	1.69	2.93	1.69	2.93	1.69	2.64
4¾	1.07	1.71	1.18	2.10	1.33	2.00	1.18	2.10	1.64	2.84	1.64	2.84	1.64	2.31
5	1.26	2.06	1.45	2.64	1.40	2.07	1.45	2.64	2.01	3.55	2.01	3.55	2.00	3.14
5¼	1.23	2.03	1.31	2.45	1.28	2.05	1.31	2.45	2.19	3.67	2.19	3.67	1.94	3.08
5½	1.30	2.12	1.50	2.67	1.43	2.27	1.50	2.67	2.31	3.83	2.31	3.83	1.89	3.00
5¾	1.26	2.05	1.45	2.68	1.31	2.07	1.45	2.58	2.24	3.71	2.24	3.71	1.83	2.90
6	1.39	2.16	1.43	2.53	1.31	2.07	1.43	2.53	2.49	3.92	2.49	3.92	1.96	3.06
6½	1.35	2.03	1.54	2.52	1.46	2.16	1.54	2.52	2.26	3.54	2.26	3.54	2.01	2.99
7	1.39	2.09	1.84	2.84	1.59	2.23	1.84	2.84	2.31	3.60	2.31	3.60	2.10	3.21
7½	1.33	1.99	1.52	2.47	1.36	2.02	1.52	2.47	2.23	3.47	2.23	3.47	2.06	3.10
8	1.42	2.10	1.86	3.15	1.42	2.14	1.86	3.15	2.12	3.40	2.12	3.40	2.04	3.09
8½	1.39	2.33	1.81	3.05	1.62	2.85	1.81	3.05	2.06	3.29	2.06	3.29	2.00	3.05
9	1.37	2.26	1.80	3.02	1.61	2.80	1.80	3.02	2.05	3.52	2.05	3.52	1.99	3.00
9½	1.34	2.22	1.75	2.91	1.75	2.90	1.75	2.91	1.99	3.41	1.99	3.41	1.96	3.36
10	1.54	2.40	1.72	2.87	1.54	2.67	1.72	2.87	1.96	3.36	1.96	3.36	2.10	3.40
11	1.67	2.49	1.67	2.77	1.67	2.74	1.67	2.77	2.12	3.44	2.12	3.44	2.45	3.90
12	1.76	2.60	2.16	3.55	2.00	3.37	2.16	3.55	2.45	3.81	2.45	3.81	2.42	4.05
13	1.97	3.08	2.36	3.72	2.19	3.53	2.36	3.72	2.42	4.02	2.42	4.02	2.39	3.98
14	2.14	3.19	2.33	3.65	2.39	3.73	2.33	3.65	2.39	3.94	2.39	3.94	2.42	4.10
15	2.21	3.42	2.42	3.74	2.46	3.85	2.42	3.74	2.46	4.20	2.46	4.20	2.46	4.20
16	2.30	3.58	2.60	3.84	2.59	4.01	2.56	3.89	2.59	4.36	2.59	4.36	2.59	4.36
17	2.36	3.69	2.75	3.96	2.67	4.15	2.69	4.05	2.72	4.55	2.72	4.55	2.72	4.55
18	2.42	3.76	2.84	4.20	2.78	4.27	2.80	4.20	2.89	4.71	2.89	4.71	2.89	4.71
19	2.55	3.90	2.93	4.37	2.89	4.39	2.96	4.37	3.10	4.90	3.10	4.90	3.10	4.90
20	2.66	4.20	3.10	4.49	2.96	4.55	3.10	4.52	3.29	5.15	3.29	5.15	3.29	5.15
21	2.79	4.39	3.22	4.61	3.10	4.70	3.27	4.69	3.45	5.40	3.45	5.40	3.45	5.40
22	2.86	4.50	3.35	4.78	3.26	4.89	3.41	4.82	3.64	5.64	3.64	5.64	3.64	5.64
23	2.99	4.69	3.47	4.89	3.40	5.05	3.53	4.97	3.79	5.82	3.79	5.82	3.79	5.85
24	3.10	4.77	3.60	5.10	3.56	5.20	3.69	5.15	3.91	6.10	3.91	6.10	3.91	6.10

FIG. 2 A MACHINE LOADING CHART BASED ON STANDARD TIME

that of another, or one plant's production compared with another, even though they are working on an entirely different product.

For instance, how could the day's work of the foundry be compared with that of the machine-shop or woodshop without the standard hour? If 50 men working in the foundry for 10 hr. produced 5 tons of castings, and 30 men working in the woodshop for 10 hr. produced 3,000 finished parts, how can it be determined which department is securing the better re-

EFFICIENCY REPORT

ROD & WIRE DEPT. DATE 19

MACHINE	NO.	HOURS						PER CENT.			DELAY HOURS							
		AVAILABLE	DAY WORK	STANDARD	ACTUAL	DELAY	CAPACITY	EFFY	DELAY	CAPACITY	DIE & TOOL TROUBLE	WAIT CRANE	WAIT METAL	WAIT PICKLE	BREAK DOWN	CLEAN UP	POWER OFF	MISC.
B B	1	120		80.2	100.2	19.8	43.5	80	16	43	.7	.7	14.3		1.9	.5		1.7
B B	2	120		64.3	98.7	21.3	39.7	65	18	40	1.3		14.1		1.8	1.4		2.7

FIG. 3 STANDARD TIME AS EMPLOYED TO MEASURE EFFICIENCY OF OPERATION

sults? Suppose that both departments are working on standard time. Then if the foundry with 50 men working 10 hr. produces 350 standard hours work, it is operating at 70 per cent efficiency (350 standard hours as against 500 man-hours). And if the woodshop with 30 men working 10 hr. produces 260 standard hours work, it is operating at 87 per cent efficiency (260 standard hours against 300 man-hours) and is thus producing better results than the foundry.

This same comparison can also be made to apply in the department and plant to determine the results produced by each machine and employee. Fig. 3 shows the form furnished to the department foreman for this record, which is of considerable benefit to him in locating the weak points in his department, thereby allowing him to pay special attention to the building up of those weak spots that are causing loss of production. Furthermore, this report not only points out to the foreman which employee is producing the best results for him, but also shows how this is being accomplished. The number of standard hours work produced is the first thing to be looked for in comparing the results obtained by the various machines. In the case illustrated in Fig. 3, Machine No. 1 has produced 80.2 standard hours of work, while Machine No. 2 produced only 64.3, the reason for this difference being easily found by following the two records across the sheet. The delay on Machine No. 2 being slightly greater accounts, of course, for a part of this loss, but the great difference in the employees' efficiency shows the reason for the greater portion.

Without some such record of actual accomplishment, the foreman is often misled as to who his best employees are. Many employees have the faculty of always being busy when the boss is around; others, though working continuously and faithfully, are more strenuous than efficient. In a great many cases these two classes of employees have gained the reputation of being the best

PRODUCTION REPORT

DEPT. _____ EQUIPMENT HOURS 1690 PERIOD FROM Apr. 1st TO Apr. 15th

MACH NO	DELAY PERCENTAGES									MACHINE CAPACITY	EMPLOYEES EFFICIENCY	EQUIPMENT PERCENTAGES			
	GRIND ROLLS	BREAK-DOWN	FURNACE OFF	WAIT METAL	TRUCK-ING	WAIT PICKLE	CLEAN UP	MISC.	TOTALS			EQUIPMENT %	AVAILABLE TO EQUIPMENT	ACTUAL TO EQUIPMENT	STANDARD TO EQUIPMENT
1	1.7	.1	1.3	.1	13.0		1.0	2.0	19.2	50	107	100	99	80	85.2
2	13.6	1.1		.1	1.1	7.4	.2	1.8	25.3	63	85	100	87.7	65.9	56
3	5.2	2.8	.3	16.5	6.3		.3	1.0	32.4	66	98	100	93.5	63.2	62.2
4	---	---	---	---	---	---	---	---	----	---	---	100	---	---	--
5	6.4	2.1	1.0	2.1	.1	6.8	.5	1.1	20.1	73	103	100	96.2	76.7	79.1
6	12.4	1.1	1.6	1.1	--	1.1	.1	.3	17.7	94	104	100	86.8	71.8	74.7
7	11.2	---	.7	3.4	---	1.4	.1	1.2	18.0	88	105	100	100	82.1	86.1
8	7.3	2.0	.7	1.1	---	1.8	.3	.8	14.0	89	104	100	100	85.8	89.2
9	14.4	--	.5	.9	1.8	1.0	.1	1.4	20.0	92	103	100	100	79.8	83.3
10	12.8	3.5	2.8	16.3	4.3	--	.1	1.8	41.0	66	94	100	100	58.4	55.1
11	9.6	.6	3.8	4.3	.5	3.3	.3	1.2	24.0	70	91	100	96.2	73.2	62.2
12	---	---	---	---	---	---	---	---	------	---	---	100	---	---	--
13	2.5	6.3	7.5	5.1	5.5	3.2	.4	6.3	37.0	38	74	100	57.7	36.3	27.0
TOTALS	9.1	1.6	1.6	4.7	2.9	2.3	.3	1.6	24.0	74	99.	100	78.0	59.5	58.6

FIG. 4 A PRODUCTION REPORT BASED ON STANDARD TIME

employees. On the other hand, the employee who does not make an effort to impress upon the boss the fact that he is very busy, and who through the elimination of all false effort is doing his work in an easy and efficient manner, is apt to be considered slow and not as good as those first mentioned. However, through a report such as shown in Fig. 3, the true conditions are brought to light and the real value of the employee revealed. When first introduced in the average plant this report brings many surprises to the foreman.

STANDARD TIME MEASURES ACTUAL RESULTS

But while the report shown in Fig. 3 gives the department foreman information regarding the activities of various employees and machines, it does not give a true measure of results accomplished by his department. The form shown in Fig. 4 is sometimes used to show actual results accomplished by each machine and department and gives the only true measure of production. This report is furnished to department heads and also to the superintendent or general manager. It is composed entirely of percentages based upon the equipment hours and available hours, the equipment percentages being based upon equipment hours or number of machines multiplied by working hours for that period.

The reason for placing 13 machines in the department shown in Fig. 4 was of course the desire to secure the output of this number of machines. Any production figures must, therefore, be based on the capacity of this department and not upon the actual number of machines used. The actual accomplishment of each machine is also based, not entirely upon the number of hours worked, but upon the number of hours the machine should have been in operation.

The figures at the left side of this report are delay percentages, showing in detail the various causes and percentage chargeable to each cause on the various machines. Each machine is charged with 100 per cent equipment under the column headed "Equipment Per Cent." The next column, "Available to Equipment," shows what per cent of this time the machine was in operation (including delays) or in other words, the time the employee was ready to operate the machine. Under the column headed "Actual to Equipment" is shown what per cent of the equipment hours the machine was actually working on production (exclusive of delays). The last column shows the percentage of standard hours work accomplished as against the equipment hours, and this is the real production turned out by this machine.

In the example shown in Fig. 4 the employees in this department were working 99 per cent efficiently for 76 per cent of their time (24 per cent delay). Yet the actual production from this department was only 58.6 per cent, and the reason for this is, of course, the two idle machines, No. 4 and No. 12.

In a plant where this form was introduced recently one foreman objected strenuously to being charged with idle machines, claiming that the machines were not in condition to be operated. When he found, however, that the management was measuring his results in this way he had the machines overhauled and they were soon in operation.

EXECUTIVE REPORT FOR PERIOD ENDING.....19.....
WHO IS OUR BEST FOREMAN?

DEPT.	EQUIPMENT HOURS	AVAILABLE HOURS	DELAY HOURS	ACTUAL HOURS	STANDARD HOURS	EMPLOYEES EFFICIENCY PER CENT	DELAY PER CENT	PRODUCTION PER CENT	REMARKS
A	1000	1000	400	600	300	50	40	30	
B	950	950	285	665	425	64	30	45	
C	900	800	120	680	680	100	15	75	
D	1200	950	47	903	794	88	5	66	
E	1100	1000	200	800	600	75	20	55	

FIG. 5 STANDARD TIME AS EMPLOYED TO RATE FOREMEN

Foremen are sometimes paid a bonus based upon the results obtained by their department, and the form shown in Fig. 5 is furnished each foreman as well as the general manager. A friendly rivalry is created, which usually brings forth some remarkable results in the way of increased production.

Wages. Premium system *658.3825*

The Premium Wage Payment System

By C. B. LORD

Industrial Engineer, Advance-Rumely Company

SINCE the pyramids, men have talked about the common interests of employer and employee, and they will continue to do so, and with the same effect. Some have preached this community of interest because they stood to gain by its observance and others because somebody else did; a little thought, however, will demonstrate that while these interests may be parallel, they are not identical, and parallel lines, it must be remembered, meet only at infinity. Their relations are really those of buyer and seller, "Caveat emptor" is still their slogan, and we have a buyer's market and a seller's market.

When one person desires to sell an article and another wishes to purchase that particular article, the parallels are close; but when there are plenty of sellers the buyer is careless, and when sellers are scarce buyers become anxious. So we may liken the interests of Capital and Labor to the interests of two men in a horse trade; the respect and trust one feels for the other depends entirely upon how badly he has been stung previously. This being so, it is a fairly safe assertion that no system of fixing payment will ever be found that will be acceptable both to those making and to those accepting it for any considerable period, figured in years and decades.

As long, therefore, as the human mind is what it is, we shall continue to dream of catching the market short, breaking the bank, finding a treasure, losing a rich uncle, finding a snap job, or having the "bones" roll right, depending upon our station and inclination.

Industry in general is on such a basis in this coun-

try that the bludgeon of strikes or the coercion of improvement organizations is no longer necessary. The employee always secures the advantage within the limits laid down, and discipline, not indulgence, spells happiness for him. And that form of management that recognizes the psychology of leadership and discipline, founded upon liberal justice and liberal compensation, but demanding the rendering of an equivalent, is in the writer's estimation not only the ideal, but the only possibly successful form.

A METHOD OF FIXING COMPENSATION ESSENTIAL

The first requirement in the type of management mentioned is a clean-cut, obvious method of fixing compensation. It must be initiated and maintained with the idea of being more than square and of giving the employee the advantage of every doubtful case, within the limits laid down. This means that the fundamentals must be right, as to alter them spells trouble. Rules are made to be enforced and must be. If they are such that they cannot be enforced, they should be eliminated.

It sometimes happens, however, that we make rules based upon perfectly logical reasons; but with the passage of time, these reasons become indistinct or are forgotten, the rule is abandoned or not enforced, and dissatisfaction results. Rules should therefore be few; they should be based on fundamentals and should be accompanied with an analysis for filing purposes.

It so happens that such a method of fixing compensation has been devised and has been in use for some time, measured in years and decades. This is the premium system of wage payment, of which F. A. Halsey is the originator. It seems peculiarly to fit present conditions, because instead of either paying a fixed price for a certain number or unit, or scaling the price up or down according to the number made, it frankly and specifically promises a part of the saving in time consumed in manufacturing; or, in other words, it offers participation in the profit earned, not in the distant, but in the immediate future. It also provides a simple, definite, yet flexible, means of fixing the amount of this participation.

THE PREMIUM SYSTEM SUPERIOR TO OTHERS

The writer is not willing, however, to assert that the Halsey system is perfect. To do so would make further reading of this article unprofitable. He is willing to assert, however, that in his opinion it is superior to the variations or combinations of the system which it has been hoped would improve and supplant it. We may as well be honest with ourselves and begin with a statement of fact, namely, that any method of bonus paying is an admission of our inefficiency in increasing the productive capacity of the workman to any appreciable extent under the day-work plan. We may say that we are prompted by a desire to have a man make more money; we may say that we wish to recognize the individual worth of each one as shown by his earnings, but all this could be easily done by the hourly system if we could find some better method of supervision. What we really do is to hold back from the man part of his wages in order to induce him to work harder, instead of fixing his compensation and forcing him to earn it. This statement does not detract in any way from the value of the premium system, or any other method of payment, as at present no better method is known.

It is always best in considering any system to find the objections to it and then the method of overcoming these objections. There are two objections to the premium system. One is that when an increase is made in a man's rate, it also increases his premium allowance. The fact that it does so, is of course ignored by the employee, and any raise granted that takes the raising of both into consideration, is apparently so small as to be unacceptable to the man. The second objection is that it means possible bookkeeping for the employee for which he is not always fitted.

The first objection is not serious and probably means that the man does not ask for an increase as often as he otherwise would. Another answer is that his rate can be basic relative to the industry and any increase made horizontally. In practice, it has never proved a difficulty, but is always a psychological reason against making an increase when one feels indisposed to do so.

As regards the second objection, that also is largely psychological, because most men do not keep track of their earnings; others are incapable of doing it correctly under any method, and lastly, some are always sure they are short no matter what the size of their pay check or the method of payment. No method of bookkeeping so far devised may be called entirely satisfactory where two diverse interests are concerned.

SUCCESS OF SYSTEM DEPENDS ON MANAGEMENT

We Americans are an odd people in that we always want to go from the zero of imperfection to 100 per cent of perfection; and while we will go for years without any system at all, when we decide to adopt one, we will reject all but the seemingly perfect one. It is amusing to read of the wonderful results achieved by scientific management in a factory where savings of 50, 60, and 70 per cent have been made; the safe conclusion to arrive at is that conditions must have been rather bad in that particular factory, and that a competent man, whether an industrial engineer or not, could have made a large saving.

So it is with all additional compensation plans. Their success depends largely upon the character of the management. Piecework in some factories may be better administered than the premium system in others. The system should be adapted to the requirements and ability of the firm adopting it, to properly administer it. For a small factory where no cost or bookkeeping department is installed, where the operations are automatic and depend upon the machine for quality and quantity rather than upon the man, the writer would unhesitatingly recommend piecework. But where bookkeeping departments are installed and costs are really kept, the premium system is preferable.

Psychologically speaking, the piece payment method is at a disadvantage in several respects, when compared with the premium method. It is unwise and unprofitable both from the standpoint of accuracy of setting, and from the effect on the man concerned, to visualize money when setting allowances, particularly when considering small parts. It is very easy to pick up a piece of work and reason to oneself; "another piece like this, but a little smaller pays three cents, this, then, should pay three-and-a-half or four." He visualizes price only, but if he were figuring time in seconds and minutes, he would have to visualize operations, and would probably reason, "the other piece is a little smaller, but this will go on the same machine and at the same feed and speed, and probably the same cut, and should therefore take no more time." *Time affords a better comparison than price.*

Piecework Payment Open to Argument

From the man's side, the psychology is that no matter what the money allowance may be, it is not enough, because in the first place it usually means small figures—two, three, four cents, the manufacturer usually losing the quarter or half cent; and it seems to him not enough because he does not consider, neither does he know, how many he can make in a full day, and his cue is to object, regardless of the price set. Any compromise or reduction means a direct loss in money to him. We can visualize only one thing at a time, and in this case money is the basis, and that means argument. If the computation is made in minutes and seconds, with the final earnings a matter of a future mathematical operation, the visualization is in time, and the man is not so tenacious. It only means, as he views it, additional effort; and the final justice is not affected. The problem is, can he do it in a given time? That involves demonstration. *Money begets argument —time begets effort.*

It is idle to argue that we can if we wish set piecework prices on a time basis. Its nature is against it; and while we use a stop-watch for rate-setting, we also have a convenient monetary basis, as "a cent a minute," and our mental arithmetic is in cents, not minutes. *Time is more accurate than price.*

The Premium System Begets Fairness

The piecework system earned an unmerited bad name because it fostered a vicious circle. First the crude method of setting the rates allowed the earnings to be out of reason, and resulted in a cut, sometimes several, and it required a mathematical gymnast to tell what the worker had earned, and only the Ouija board could forecast what he might make. The result was dissatisfaction, then reduced output, and then commence over again. A time guarantee on allowances is one of the fundamentals of the premium system; it was considered rather radical at first, but has since been incorporated into other methods until today changing requires an apology, and is resorted to only when important changes are made in design, method of handling, machinery used in manufacture, or lot quantity limits, and some firms never change their allowances. This one can more readily afford to do with the premium system than with any other system, because of the mutual sharing feature; therefore the premium system begets fairness.

We have heard much from parlor socialists and organized labor regarding the slave-driving, nerve-racking efforts of any bonus system. Experience or tests fail to substantiate this declaration and seem to prove quite the contrary; one writer at least goes so far as to admit that "where a bonus does not induce overexertion, it renders the work easier by adding an interest." It appeals to American temperament to reduce the time in which a thing may be accomplished. With a premium, the reduction is observable in every piece and maintains interest, while the larger output is observable only at the end of the day. But lest we deceive ourselves, let me add that somewhere, somehow, sometime, we must pay for our manufacturing methods, not because of any bonus system, nor because of slave-driving or longer hours, but because doing the same thing day after day induces "repetitive" fatigue; as individuals and as a nation, we must, unless we are "brothers to the ox," break out somewhere, sometime.

The Principles of the Premium System

What can be more dreary or more deadening to ambition than the old method of doing the same thing ten times an hour, or ten times a minute, and seeing no end of it, no reason for it, no benefit to oneself, no incentive to work? Piecework altered that, but it substituted an uncertainty in that a man was paid so much a piece, with no minimum guarantee. If we had plenty of stock, if his machine did not break down, he could figure at the end of the day how much he had made, and he had that interest to sustain him; but neither management nor labor was fair in its application, and piece payment fell into disrepute. Then came Mr. Halsey with the premium system, and under that system the man knows he will receive his hourly rate no matter what happens. This was the second radical proposal in Mr. Halsey's system that is now recognized as fundamental in all.

Briefly stated the principles of the Halsey system are:

1. A possible minimum
2. An added 50 per cent to Item 1
3. Equal division of time saved under Items 1 and 2
4. Hourly rate guarantee
5. Time guarantee on allowances

The time is set, not the price, which is variable, and a possible minimum is not necessarily an irreducible minimum.

The Halsey system is not, however, a preventive of loafing, nor a panacea for laziness, and the man who kills time on day work simply changes his habit and kills quality to make more money. But let me, with all the emphasis possible, refute the idea that poor quality is inherent or attributable to any bonus method of payment. Good work is a matter of insistence.

Accumulative Skill As a Factor in Production

Proof That Group Experience and Pride in Work Increase Output

By HUGO DIEMER

Director, La Salle Extension University

THIS is the story of the confirmation of an intuition—an intuition that among workers there is a group conscience. The individual who had this intuition is today a college professor who, formerly a shop man, had spent about fourteen years in various capacities from apprentice to shop superintendent, and some ten years in studying the ways of college boys and trying to teach them engineering from an industrial and manufacturing standpoint. During this last period, and in doing advisory work on organization and management for manufacturing concerns, occasional ventures were made into the field of organizing and conducting classes and conferences of practical workers—foremen and superintendents—to study the ways and means of modern industry. Moved by the wave of patriotism and the desire for service, the college professor became an ordnance major, and was fortunate enough to be stationed at a post where he was free to exercise his initiative, and to do his bit in producing results.

The post-war restlessness together with the taste for shop life drew him back again into industry for about a year and a half, where he was engaged as personnel superintendent and compelled to busy himself primarily with the frenzied rush for more help and more production. Then came the signs of an impending lull, and he was told that, instead of hunting for help, he might utilize some of his time by studying the various production and cost records and see whether by reason of his past experience he could make any interesting and worth-while discoveries.

A Study of Production Deliveries and Employment

Among the data submitted to him were tabulated figures showing the monthly production deliveries for different departments. These departments included some devoted to products that had been manufactured for years, and some devoted to products of more recent origin. After studying the production figures for some time the thought struck the investigator that a graphical presentation might bring forth some disclosures. Some large sheets of cross-section paper were accordingly obtained and a sheet was allotted to each product. The abscissae were taken to represent time, and the ordinates production, and as might have been expected, the resultant production curve was a zigzag line, owing to fluctuations in the material available for use and the help employed. Then the employment records were looked up, and the number of men in each shop making a given product was plotted against weekly periods. These points also gave a jagged line and it was thus apparent to the investigator that the two curves were of no value.

A Comparison of Cumulative Averages

Then came the idea of seeing what would be shown by cumulative averages. In other words, production for two months was divided by two, and a point was put midway between the points indicating the first and second month's production; similarly, the production for three months was divided by three with a point midway between the second and third month's production.

The cumulative average number of employees was taken in the same way and points were plotted showing the average number of employees in each shop during the first two months by dividing the sum for the first and second month by two and putting the point midway between the first and second month, and so on. Next, the final curve was produced, this being the quotient of the cumulative production divided by the cumulative average number of employees. This curve represented the cumulative average production per employee in each shop, and as this curve went up or down it showed whether production had been on the increase or decrease.

The result of this curve was an instantaneous verification of the intuition. It showed that in the two oldest established shops which had been working on the same product for over twenty-five years, the cumulative production per employee showed a steady upward trend through both 1919 and 1920, at a rate approximating the legal rate of interest. We had heard a great deal about labor's post-war inefficiency, yet those curves showed that, although the shortage of labor was twice as severe in 1920 as in 1919, and although the labor turnover was twice as great in 1920 as in 1919, the curve of increased production did not change the angle of its upward slope.

The fluctuations in the supply of materials were even more severe and annoying than those in the supply of help, but the old force seemed to take the up-grades and the down-grades like an experienced, conservative automobile driver who knows when to save his gasoline and when not to put an undue strain on his motor. Periods of low production due to lack of material were followed by periods of intensified production when everything was available.

The two shops which had been working on the old-established product were probably spared any experi-

mentation with new methods of control or manufacture. The working force, from the employees up to the general foremen, were shrewd, philosophical Yankees, or, if foreign born or of foreign extraction, they had acquired the American outlook and viewpoint of life. To them, changes among the superintendents or the officials meant little. Their loyalty was first to their crafts, second to their fellows, and third to their institutions, with very little sentiment of any sort for proprietorship or officials. A newcomer was taken at his own estimate of him. In the parlance of modern management, he had first to sell himself to them on a manhood basis. Even though he had completely sold himself and was accepted on this basis, it was still problematical whether the force would accept his ideas on production, organization, management, industrial relations, or human engineering, although his methods of management certainly stood a much better chance of acceptance than those of the man who had not sold himself on a manhood basis.

GROUP CONSCIENCE OR PRIDE IN WORK

From the fact that the old working force steadily increased its production per man with very little outside aid, it is not to be inferred that all working forces will increase production if left alone. The increase in this case does indicate, however, the presence of a group conscience or pride which exists in almost all long-established working forces but which too many managements fail to recognize. Yet the mere recognition of its existence will go a long way toward developing it. It is disheartening to groups of this sort to hear talk about labor having "marked time" since the war, and similar unmerited criticisms. To strengthen and develop this group conscience requires real leadership. This leadership must be free from intrigue, duplicity, and crookedness, and the surest way to develop this group conscience is on the basis of manhood.

If the incident cited were an isolated example it would hardly be worth noting. It is very likely, however, that what was true of this company is true of other concerns all over the country, namely, that there is not only a group consciousness in well-established departments, but also a distinct group conscience. The writer feels that he is especially appreciative of this conscience, because he has had intimate association with foremen and mechanics in their lodge and social gatherings. He has gone to their meetings, impelled not so much by any sense of obligation, but simply for the reason that he likes the men. The men unconsciously sense this. An executive who unconsciously sets up barriers of social distinction between himself and the workers under him will never be accepted on the basis of complete confidence, no matter how suave he endeavors to make his "approach."

WORKERS ARE CLOSE STUDENTS OF ECONOMICS

The wage-earner is also a much closer and more intelligent student of economic and political conditions than most managements believe him to be. We all know that no matter how broad-minded and patriotic are the formal discussions at manufacturers' associations, chambers of commerce, and similar meetings, there are always little group conferences and discussions of policies at the "sidelines," both before and after the meetings, in which a feeling of resentment toward the working force makes itself felt. It is unfortunately true that the feeling shown in these discussions is apt to reach the established groups who really have a conscience developed almost, as it were, by a sense of telepathy.

The works manager or superintendent who, in the opinion of these workers, is "too slick," "too suspicious," or "crooked," simply cannot appeal to their better nature. Nor can the general executive who on occasion, like the monarch of old, steps down from his patriarchal platform and deigns to come to the workmen, entering their presence like a royal ruler reviewing a military parade, or a don in college cap and gown about to give an oration. Even though his secretary has translated his address into simple one- and two-syllable words and has carefully arranged the impromptu talk; and even though a spellbinding elocutionist has given the chief executive lessons on his impromptu speech, it simply will not "get across" with these old-established workers.

THE SPIRIT OF THE MANAGEMENT

Among the writer's friends is the vice-president and personnel manager of a large corporation employing some five thousand men. At one time he was timekeeper, later the paymaster, then employment manager; and during the year 1920 his company had as low a labor turnover as any known to the writer. And yet while it is true that this company provides all the "service" features of the progressive personnel management and, in addition, employees are given shares of its common stock as a service and efficiency bonus (over one-fourth of the employees are stockholders in this way), it is nevertheless not the service features nor the stock ownership that have won the loyalty and co-operation of the working force. It is the spirit of democratic Americanism in the management, which does not manifest itself through shop committees or councils but in simple, straight, open honesty and fairness to all.

Such a management can appeal to the natural enjoyment of breaking previous records and the desire to do well, but the superintendent who is "too slick," "too suspicious," or "crooked" cannot do so. Old-experienced foremen may never have made a scientific analysis of their knowledge of human nature, but they do know when a superintendent or general manager is, as they say, "too slick." Let us therefore not forget that a stream cannot rise higher than its source, and remember that if we wish for greater production by appealing to those instincts of the worker involving desires based on high character standards, there must be similar standards on the part of management.

Production As Affected By Size of Plant

Recent Developments Permit Small Factories to Secure Most of the Advantages Commonly Claimed for Large Plants

By G. S. RADFORD

Consulting Management Engineer

ONE of the outstanding features of the rise of our industrial civilization has been the erection of large manufacturing establishments and the creation of correspondingly large organizations to operate them. Under the stimulus of war demands for the products of industry we have seen many of these plants and their organizations expanded prodigiously, and huge new ones added. The tendency has been almost entirely in the direction of greater size and consequently toward greater complexity, both in factory arrangement and in organization, seemingly without limit.

Granted that there are undoubted advantages accruing to the large plant, nevertheless, there are a great many disadvantages. In fact, problems and troubles which grow to serious proportions in large establishments are often insignificant and negligible in the small factory. The troubles or difficulties due to size alone may even become the paramount problems of management, as they certainly do if the plant is large enough. So the question naturally arises as to whether there is not a limiting size for every factory beyond which it is neither economical nor wise to allow it to grow. The writer believes conditions to have so changed that the causes which have tended to bring about the existing concentration of industry are no longer operative, and that modern developments now permit industry to obtain most of the advantages of the large plant in factories of smaller size with certain exceptions to be stated presently. It is his endeavor to show at least that it is time for the engineer to stop and take stock of the situation before he gives his professional approval to the continued expansion of industrial units.

Conditions That Make Necessary the Large Plant

No astronomical theory of relativity is needed to show that size in manufacturing plants is a relative matter. To operate at all some plants have to be large and, for economy's sake, others ought to be. As these establishments are exceptions to the subject under discussion, namely that to the growth of plants a limit can be and should be set, let us take them up now and get them out of the way.

To the exceptional class belong the enterprises whose geographical location is fixed. They cannot operate elsewhere. If an ore deposit is concentrated in a given locality, the mine cannot very well be moved. For similar reasons, the point where ore, fuel, and flux can be most economically brought together, locates the smelter and fixes its size at the same time. Then there are the plants which must be large because they deal with massive work, as in a shipyard or steel mill, or because they must be operated on a large-scale production, as in a chemical works.

When the establishment must be large because of the nature of its production, the problems of management become complex only when the operating force is correspondingly large, or when the product is complicated in design. Even in these cases, the endeavor to decentralize the control, as far as may be practicable without losing co-ordination of management, will result in the simplification of the problems of management.

Of the factories that are large, some of them are the result of gradual expansion, others were deliberately built on a big scale at the start. Why? The question cannot be answered without analyzing the advantages of the large plant; but before dealing with this subject let us consider the effect of certain modern developments in many things which were once of prime importance in determining the location of a plant but which no longer need serious consideration.

The Effect of Modern Development

A factor of primary importance in the establishment of a plant in the early days of industry was the need of locating near a source of power; but today with the efficient long-distance transmission of electrical power this necessity no longer holds. Even where outside power is not available and independent power plants are in use, there is little difference in power efficiency between a moderately large plant and a very large one. The chief consideration is, then, a sure supply of fuel at reasonable prices.

A second factor governing the upbuilding of industry in former days was the need of locating near an industrial center, with its assured supply of raw materials, of adequate skilled labor, and of means for shipping the finished product. Of these former necessities two have been dissipated very largely by improved and widespread transportation. In the case of labor, unless a plant needs to be located in or near an industrial community of craftsmen or skilled workers, as in the textile trades, there is no special reason for grouping a number of production units in one huge industrial center. On the contrary, a smaller and more nearly isolated unit may enjoy many advantages in building up and retaining a skilled labor force; advantages which will later be dealt with in detail.

The advantage of buying in large quantities is unquestionably important, but a chain of factories under a central purchasing organization can avail themselves of this economy just as well as if all the organizations were concentrated in one plant. This assertion is borne out by the success of the chains of retail stores that have sprung up in every town of any size throughout the land.

When the economies due to mass production are considered it is assumed that the organization is large enough to permit the continuous operation of the most modern machines and equipment. If the production is in sufficient volume to keep the whole of the plant continuously employed there is little to be gained, so far as concerns economical production, by further expansion in the same locality.

Finally, there is the vital consideration of overhead expense; and here it must be admitted is where the large plant is usually thought to be more economical in operation than the smaller organization. This is true only to a certain point. When a plant in a given industry has passed a certain size is there such a great economy after all? Is not the economy more apparent than real, especially when contrasted with the disadvantages that accrue? The fairest basis of comparison would seem to be to compare the pay-roll ratio of producers to non-producers, so-called, when the work is performed in one very large plant, and when the work is distributed among two or more separate plants, with a central staff for controlling design, purchasing, selling, quality, etc.; in short for co-ordinating the different units.

Such a comparison is one means of determining the most economical size of a manufacturing plant. Even if the figures are in favor of the large plant, there remains still to determine whether any slight reduction in overhead due to concentration is not more than offset by possible disadvantages due to size alone.

The Disadvantages of Very Large Factories

What are the chief disadvantages under which large plants labor? In the first place, as an organization grows, complexities of management and control arise and a greater expenditure in overhead is necessary to co-ordinate the more widely distributed activities. This lack of close contact not only increases the obvious overhead expense, but also results in a certain amount of wasted time and effort that is difficult to detect or eliminate. For example, in a large munition plant visited by the writer there were several main arterial corridors, 1800 ft. long, running through the length of the plant. At any time of day, a glance down one of those corridors would reveal dozens of men moving materials, conveying messages, or attending to matters that called them from one part of the plant to another. The factory discipline was good, and all these employees had every appearance of being properly engaged. The sum total of time spent in such movement represented an appreciable overhead expense and one difficult to reduce. It illustrated, moreover, in a marked form a part of the cost that is paid for the longer haul necessitated by the large plant.

Quality of Output as Affected by Size of Plant

While there is no need to enumerate in detail the many losses inseparable from the operation of a large plant there is one important matter that should not be overlooked, namely, the control of quality. Its mention should be sufficient to indicate the important bearing of the size of a plant upon the quality of its output. Nobody experienced in factory operations will dispute the statement that quality is much easier to safeguard in a small plant than in a large plant. If in a large organization the quality of an article is in doubt, it is usually given the benefit of the doubt because a high order of judgment is often requisite to determine quality. When appeal is made to the highest authority to pass upon the quality of a piece of work the importance of that particular piece becomes less as the factory becomes larger. The question of its fitness remains just as important as ever, but the importance of any piece of work in the eyes of the manager dwindles into insignificance in comparison with his other responsibilities. If the work cannot be carried to him, he must walk to the work. Hence he delegates the duty of inspection, and it is perhaps redelegated until quality becomes a matter of casual inspection by subordinate inspection and the ideal of producing the best possible has faded away.

The long haul operates in other ways to increase the overhead of huge plants, for transportation lines are long, and raw materials and the many little consumable supplies that are not called for until they are needed are then remote from production points. Of course, foremen should foresee such needs, but being human, they don't, and it takes time to supply them, all of which causes delays that cost money. The bigger the factory the more expensive becomes the very careful planning and dispatching necessary to avoid the delays and congestions which pile up the overhead in proportion to the size of a plant. Then again there is the matter of serious breakdowns, and of a possible if improbable fire, and their effect on manufacturing operations. The principle of "not having all your eggs in one basket," applies to industry as well as to marketing.

The Effect of Size of Plant on the Labor Problem

Breakdowns, however, are not the only cause of stopping work. There is a much bigger loss, a loss and waste that in recent years has been greater than ever, caused by strikes both "on the job" and of the old-fashioned variety. If the cause of this loss and waste cannot be eradicated it is at least worth while to study the conditions that make for happiness and content among workers.

A criticism of the modern industrial system with which the general public is always in sympathy is that in our huge industrial establishments, a working man loses his identity and becomes merely a cog in a great

machine; his personality is submerged under a mass of detail, and the development of his faculties is limited by the repetitive nature of his task. Also from the point of view of the old personal relationship between the owner of a business and his employees, the machine-like tendency of modern industry is to be deplored as de-humanizing to the individual and destructive to the spirit of craftsmanship. The "professional pride" of the skilled worker in his job vanishes and he has no incentive to do his best if the enthusiasm and pleasure in doing good work and work that is worth while is destroyed. A worker discontented with his job is likely to be discontented with his wage. So, closely linked with this phase of the labor problem are the insistent demand for a bigger share of the profits of industry and more of the good things of life. Obviously, these demands can only be accomplished through and by means of this selfsame industrial system, but this fact is often lost from view.

To satisfy these demands in a practical way and to meet these objections to the industrial system without destroying its benefits, is the present and urgent problem of the management engineer. Who else is so fitted to act as an intermediary between labor and capital, and in so doing to safeguard the interests of the public? But the problem cannot be solved until the individual workman knows and feels that his interests and his welfare are merged with the welfare of his employer. The owner or manager of a factory may have the fairest and most humanitarian attitude toward his men but until the man in the ranks knows this to be the case there can be no effective co-operation between management and men.

Lack of Contact Between Management and Men

Granted that harmony between two conflicting interests cannot be completely or permanently attained, we must still remember that it is not even approximated in our large factories. The workman often has barely a speaking acquaintance with his foreman (who is too frequently autocratic or overbearing in his attitude) let alone knowing anyone higher up; while in a plant employing four or five thousand men or more the higher executives hardly know their own foremen. But when the organization is smaller, executives have a better opportunity to come in contact with the men in the ranks and to show that they are interested in the general welfare of the workers even if this approach must be made mostly through foremen. Though collective bargaining and representation have their field, in the opinion of the writer the best solution of labor problems lies in the better relationships established by personal contact between management and men and is not to be found in any general or mass solution. The smaller plant lends itself more readily to such personal and sympathetic contact. The "chain of command" from manager to workman is shorter, and even if the plant is still so large that management must be carried on largely through foremen, nevertheless the better the management knows its foremen, the more nearly will it approach the ideal of knowing its men. The chain of command may be just as different as telegraphing is from telephoning, or as telephoning is from looking a man in the eye while you are talking to him.

Another aspect of the labor problems of the huge factory is the housing of its workpeople. To obtain habitable living conditions the men usually have to travel to and from the plant. As a rule they live in flats or tenements and have less opportunity or incentive to own their own homes. The factory that is somewhat removed from a large industrial city suffers less in this respect. Living is better and cheaper, and the factory morale is strengthened by a community spirit bred of better acquaintance with each other. Though there are many examples of a well-run and efficient plant located in a small town or its own suburb where it forms the heart of the village life, such institutions are as yet too few in number to have had much effect upon the health and the welfare of our social life.

Before You Build a Large Plant—Think

In all previous stages of our industrial history, it was not considered feasible to erect a plant at any distance from the large industrial centers; hence the growth of our cities. But transportation in its widest sense is today available almost everywhere and the centripetal forces no longer draw industries together. Certainly they do not operate to any such extent as formerly. This change has come about by degrees and almost unnoticed.

From all this the conclusion seems clear that if you are about to build a plant and you think you *must* have a very large plant, then isolate it to a reasonable degree, at least do so if this is at all possible. It is to the interest of the working force directly for the reasons previously stated, and to the plant indirectly, but none the less surely.

The next conclusion is that if you *think* you *must* build a very large plant and especially if time is an important factor, it is well to do some more thinking before beginning the project. Though the lessons of the war proved that it is *possible* to build, organize, and operate a large plant under pressure for time, nevertheless there are so many factors entering into the problem which are all opposed to success, that there is every reason not to make the attempt. To plunge into industry on a big scale is one of those things that is theoretically possible but which is not realized in practice except under the rarest and most favorable circumstances. The odds against success are too great.

Generally speaking, it takes time to develop a stable organization. It must be built slowly and solidly from the ground up, with that thoroughness in attention to detail that takes time and lots of it. A better result and a much more economical application of effort will be obtained from a number of smaller units.

There can be, of course, no cut and dried method of determining the most economical size of an industrial plant and the problem is not to be arbitrarily solved.

On the contrary, the working solution, like so many of the problems of the management engineer, must be found in the application of good judgment to existing conditions and in evolving the best compromise. In seeking a solution it is well to consider carefully whether all the advantages of the large plant cannot be obtained in several smaller and separate units under a central control. If such an organization can be worked out, many additional and very desirable things will result, not the least being a healthy and friendly competition between the component units. Such competition, when carried on in an atmosphere of good feeling, is of the essence of efficient operation and of good-will between management and men.

Employment management 658.4

Classifying Help Through Forms

By ROBERT MAWSON

INDUSTRY is now passing through a crisis such as it has never before known. On the one hand, the engineering side of business is asking, and asking in vain, for designers; and on the other, the shop or production side is demanding machinists, but machinists of a much higher class than those it has been getting since the war. In order that a country may hold its trade or bring it back in case it has been lost, it is necessary that the work produced be of a high quality; and for the production of such work high-grade men are absolutely essential. If, therefore, as we are often told, there is such a scarcity of good men, the only method by which the problem can be solved is in two ways: First, selection of the men, and second, training of the men employed.

The trouble with many firms is that they view the situation from the wrong angle, or perhaps they try to solve the problem only partially and therefore never attain full satisfaction. The writer has been in plants where the management have been proud, and justly so, of their equipment, which was of the latest type, and when handled by good men turned out accurate parts quickly. Other concerns rely on their executives—men who have had an education and training which enables them to meet any emergency. Again, other concerns point out their systems as being their strong feature for competition in the engineering industry, systems which, they tell us, automatically carry the work through the various departments and require little or no thought on the part of the operators.

But while all these are important, the most important of all is that unknown factor in every shop, the employee, and of the employees in machine shops there are two classes: the skilled and the unskilled. It is the foreman's difficult task to take these two grades of men and women and place them in the best productive positions. One such system for doing this is by means of application blanks such as are shown in Figs. 1 and 2.

Fig. 1 shows the record of a skilled employee, giving first his name and address, and then his previous experience, namely, lathe work 3½ years; milling, 1 year; assembling, 6 months. Ordinarily, therefore, such an applicant would be most valuable as a lathe operator. It might be found, however, that the man took the most interest in assembling operations, though he has had the least experience on this class of work. In such a case, if the man proved a failure on the lathe, it would be the important task of the foreman to try him out on assembling before dismissing him from the company's employ. Hiring and firing never paid any

SKILLED HELP APPLICATION
J. R. MITCHELL AND CO.
TORONTO, ONTARIO.

Date Jan. 29/21 Number 1423
Name James B. Smith
Address 156 King St. City.

Position held	Length of Service
Lathes	3 years 6 mo.
Milling	1 " 0 "
Assembling	0 " 6 "

FIG. 1 APPLICATION FORM FOR SKILLED WORKERS

concern, and it is far better to educate the employees already in service than to have a large labor turnover.

Fig. 2 shows an application filled out by one of the unskilled class, containing his name and address and the lines of work he is chiefly interested in, in the order of preference. Such a statement of preference may be

UNSKILLED HELP APPLICATION
J. R. MITCHELL AND CO.
TORONTO, ONTARIO.

Date Jan 27/21 Number 1462
Name Thomas Jones
Address 12 Church St. City
Position desired 1ST 2ND 3RD

Lathes
Planers
Drills

FIG. 2 APPLICATION FORM FOR UNSKILLED WORKERS

difficult for many men, but when making application for employment all desire to work at some particular line or other, whether on machines or bench operations. After a good tryout the foreman can quickly see whether the man's aptitude is such as to justify the choice he made on his application blank. It may indeed be necessary to change the man several times before finding the station to which he is best suited; but if the man shows care and a desire to learn, a good foreman will eventually place him.

Referring to the illustrated application blanks, it will be seen that the date is filled out, and also that a number is assigned to the applicant to assist in keeping the records. On Fig. 2 the worker fills in the position desired according to his first, second, or third choice. The nature of the rest of the data furnished is obvious by referring to the figure.

THE LABOR SUMMARY

Statistics and News from Industry

Unemployment Continues to Increase

UNEMPLOYMENT throughout the industries of the country still continues to increase, and, according to test figures gathered by the United States Employment Service of the Department of Labor, more industrial workers were thrown out of employment during June than in any previous month since the first of the year. An analysis of the statistics available, which are based upon pay-roll figures from 1,424 firms who normally employ 500 or more, shows that whereas there were 1,573,538 workers employed on May 31 only 1,527,124 were at work on June 31, a net decrease of 46,414, or 2.9 per cent. The total decrease since January 31 has been 101,010, or but 6.2 per cent.

The data supplied to the United States Employment Service is compiled and published so as to show the trend of unemployment both by industries and geographical districts. The 14 groups set up by the United States Census are used as a basis for the first classification, while the country is divided into 9 districts for the second. Tables 1 and 2 on the following page show the distribution on this basis for the months of May and June, while Figs. 1 and 2 show the trend since the first of the year.

As will be seen from Table 1 and Fig. 1 the iron and steel industry again shows the greatest loss of workers, there being a decrease of 19,701 during June as compared with the month previous. Seven other industries (miscellaneous industries, railroad repair shops, chemical and allied products, vehicles for transportation, metals and metal products other than iron and steel, lumber, and paper and printing) also show a decrease from May 31, while the remaining six industries (tobacco, leather, liquors, stone, textiles, and food) show an increase. Tobacco manufacturing, it will be noted, has had the greatest increase of all, there being 3,387 more workers, or 12.8 per cent, employed during June than in May.

As shown by Table 2 the states of Ohio, Indiana, Illinois, Michigan, and Wisconsin, comprising the East North Central District, have witnessed the greatest increase in unemployment, as 26,175 workers in this district are reported as being dropped from the pay-roll during June alone. Of the other sections of the country all report corresponding decreases with the exception of the West North Central and the Mountain and Pacific Districts. These three combined show the slight increase of 1,132.

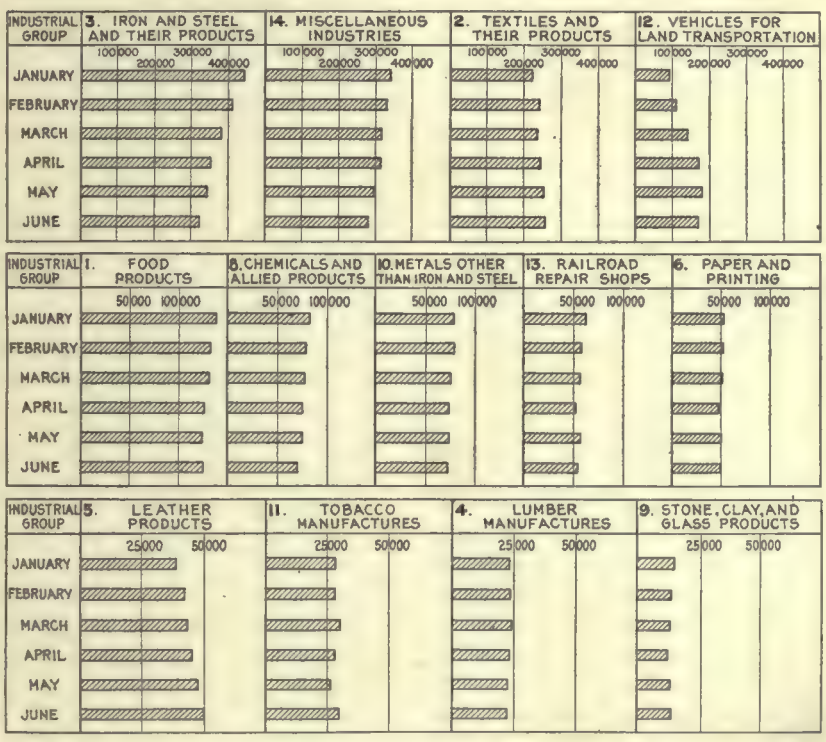

FIG. 1 THE TREND OF EMPLOYMENT IN AMERICAN INDUSTRIES SINCE JANUARY, 1921

In commenting upon this continued increase in unemployment, F. I. Jones, Director General of the United States Employment Service, says:

Detailed examination of the present returns indicates clearly the fundamental causes of the protracted industrial depression and the mounting tide of unemployment. Continued unsatisfactory conditions of transportation, the freight rates in many instances considered almost prohibitive, lack of anything like a normal foreign market, the present low value of farm products, stagnation in iron and steel, high cost of construction and general dullness of the retail trade stand out prominently as leading factors in the situation.

In addition to its statistical information covering unemployment, the Employment Service publishes through its Bulletin news items concerning the status of employment throughout the country, and from this news comment section the following paragraphs have been prepared:

New England District. Continued unemployment and part-time prevail throughout the district. The metal trades have fallen off, but textiles have shown a decided improvement, as evidenced by woolen cloth and worsteds, which are nearly normal.

Cottons, generally, are on a 75 per cent basis, with best showing in ginghams, bleached domestics, and percales. Shoes have shown a big improvement. Lumber is still depressed. Controversies in the building trades have been for the most part settled, though they still persist in the pulp mills. Retail trade has fallen off, except at several points in the southern part of the district.

Middle Atlantic Division. Notwithstanding that business men expect improvement in the fall, unemployment continues to increase in many lines. Many industries are operating on a part-time basis. The usual summer business slump has offset some of the improvement which was evident last month.

East North Central District. There has been no great change in the industrial situation during the past month, and none is expected until construction costs and railway rates are materially reduced. With the settlement of controversies in the building trades, work will be resumed on manufacturing plants, office buildings, and theaters. There is no indication that the present industrial depression will end during the summer. In the mining districts, copper mines are closed down, iron mines are operating part time, and coal mines are closed down.

West North Central District. Unemployment in the larger cities has been somewhat relieved because of the early wheat harvest. Larger farm crews than usual will be needed until September, and many skilled artisans and ex-service men have applied for this grade of work. Manufacturing has decreased in many lines, and building is quiet.

South Atlantic District. There is a slight improvement in employment conditions over the past month. Textile reports from Virginia, North and South Carolina, and Georgia, showing employment of 54,237, indicate increases ranging from 1½ per cent to 6 per cent in operating mills in these states. On the other hand, industrial disputes have thrown out of employment some 2,000 operators. Textile manufacturers generally are less optimistic. Steel and iron, machine shops, foundries, and fertilizer plants continue to show reduced forces. Lumber mills in Florida, South Carolina, and North Carolina, show some increase in employment, while fiber silk mills are also increasing their forces.

TABLE I. NUMBER OF WORKERS EMPLOYED IN 1,424 AMERICAN INDUSTRIES MAY AND JUNE, 1921, TABULATED ACCORDING TO INDUSTRIAL GROUPS

(Compiled by the U.S. Employment Service, U.S. Dept. of Labor)

Industrial Groups	Number on Pay-Roll		Net Change
	May 31	June 30	
1. Food and kindred products	124,810	125,711	+901
2. Textiles and their products	253,743	256,322	+2,579
3. Iron and steel and their products	344,958	325,257	—19,701
4. Lumber and its manufacture	22,814	22,679	—135
5. Leather and its finished products	47,178	49,936	+2,758
6. Paper and printing	49,916	49,802	—114
7. Liquor and beverages	1,691	1,758	+67
8. Chemicals and allied products	76,186	71,858	—4,328
9. Stone, clay, and glass products	14,197	14,594	+397
10. Metals and metal products other than iron and steel	74,571	72,963	—1,608
11. Tobacco manufacturers	26,438	29,825	+3,387
12. Vehicles for land transportation	181,474	172,612	—8,862
13. Railroad repair shops	58,100	54,710	—3,390
14. Miscellaneous industries	297,462	278,828	—18,634
Totals	1,573,538	1,526,855	—46,414

East South Central District. Many factories are operating on reduced schedule. Lumber reports few orders, though inquiries are plentiful. At least 100 tipple mines in Tennessee and Southeastern Kentucky, representing about 40 per cent of the total number in the district, have been closed since the first of the year. Such mines as are operating are those loading railroad fuel on contract. There are approximately 6,000 miners unemployed throughout the district, a reduction when compared to the figures for a month ago.

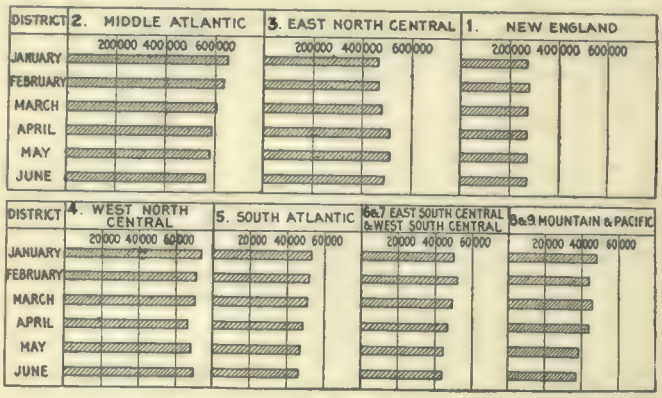

FIG. 2 HOW UNEMPLOYMENT HAS VARIED IN THE UNITED STATES SINCE JANUARY, 1921

West South Central District. There has been little change in the industrial situation, unemployment continuing to be serious throughout the district. Lumber, which for a while showed improvement, has again fallen off, while oil operations are greatly curtailed because of reduced prices for the crude product. The wheat harvest has afforded some temporary relief, while it is hoped that reduced freight rates in Oklahoma and the bankers' pool for the benefit of cattlemen will do much to improve the general business situation. Concensus of opinion indicates gradual betterment.

Mountain District. Public works are providing considerable employment throughout the district, while prospects for re-employment in mining and railroad activities are somewhat brighter. There is a seasonal increase in the demand for agricultural workers—building is restricted principally to business

TABLE 2. NUMBER OF WORKERS EMPLOYED IN 1,424 AMERICAN INDUSTRIES, MAY AND JUNE, 1921, TABULATED ACCORDING TO GEOGRAPHICAL DISTRIBUTION

(Compiled by the United States Employment Service)

District and State	Number on Pay-Roll		Net Change
	May 31	June 30	
1. New England (N. H., Mass., R. I., Conn.)	271,618	271,559	—59
2. Middle Atlantic (N. Y., N. J., Pa.)	584,675	565,163	—19,512
3. East North Central (O., Ind., Ill., Mich., Wisc.)	517,608	491,433	—26,175
4. West North Central (Minn., Ia., Mo., Nebr., Kans.)	68,500	69,480	+980
5. South Atlantic (Md., Va., Ga.)	47,786	46,735	—1,051
6–7. East and West South Central (Ky., Tenn., Ala., La.)	44,758	44,010	—748
8–9. Mountain and Pacific (Colo., Wash., Ore., Cal.)	38,593	38,745	+152
Total	1,573,538	1,527,125	—46,413

structures, though some residence construction is reported. A more optimistic feeling prevails.

Pacific Division. Conditions on the Pacific Coast are more encouraging, with renewed lumber activity relieving the employment situation gradually. In rural districts and in the canning industries the demand for labor is tending to decrease. Industries generally are attempting to stimulate trade by drastic price cutting. Declining construction costs have accelerated home building in the large coastal cities.

Industrial Immigration and Emigration in 1920

MORE industrial workers left the United States in 1920 than entered is the fact disclosed by a study of the report of the Commissioner General of Emigration for the fiscal year ending June 30, 1920. According to the figures given in Tables 3, 4, and 5, which were compiled for MANAGEMENT ENGINEERING from the commissioner's report, the number of aliens arriving who may be classed as industrial workers totaled 136,970 while the number departing was 202,808, or a net loss of 65,838. The grand total of all immigrant aliens admitted during the same period was 430,001 and the number departed 191,575, or an excess of immigration of 138,426.

TABLE 3. INDUSTRIAL IMMIGRATION AND EMIGRATION TO THE UNITED STATES DURING 1920

Occupation	Admitted	Departed
Electricians	1,109	106
Engineers (professional)	1,649	281
Blacksmiths	1,013	278
Carpenters and Joiners	5,742	1,481
Clerks and Accountants	12,681	2,344
Engineers (locomotive, marine and stationary)	1,856	378
Iron and Steel Workers	1,515	174
Machinists	3,278	990
Masons	2,235	429
Mechanics	2,942	554
Miners	3,081	5,279
Painters and Glaziers	1,021	326
Shoemakers	2,978	791
Tailors	3,074	714
Weavers	1,695	360
Other Skilled Industrial Workers	4,269	1,662
Laborers	81,732	183,820
Miscellaneous Industrial Workers	5,100	2,841
Total	136,970	202,808

TABLE 4. GEOGRAPHICAL DISTRIBUTION OF INDUSTRIAL IMMIGRANTS AND EMIGRANTS

District	Admitted	Departed
1. New England	24,477	19,597
2. Middle Atlantic	47,110	104,818
3. East North Central	23,279	52,662
4. West North Central	2,958	5,175
5. South Atlantic	3,146	5,644
6. East South Central	364	306
7. West South Central	21,149	1,322
8. Mountain	4,139	3,342
9. Pacific	10,224	9,369
Total	136,846	202,235

The occupations of these industrial immigrants and emigrants are given in Table 3, while Tables 4 and 5 show, respectively, their geographical distribution in the United States and countries of origin. Table 4, it will be noted, has been arranged to show the distribution on the same basis as the Employment Service Reports presented in the first item of the summary.

TABLE 5. COUNTRIES OF ORIGIN OF INDUSTRIAL IMMIGRANTS AND EMIGRANTS

Country of Origin	Admitted	Departed
African (black)	2,303	242
Bulgarian, Serbian, and Montenegrin	311	19,804
Chinese	43	1,534
Croatian and Slovenian	70	6,375
Dalmatian, Bosnian, and Herzegovinian	27	1,264
Dutch and Flemish	2,092	981
English	15,185	2,875
French	6,332	1,589
German	1,370	1,465
Greek	8,510	17,916
Hebrew	2,477	141
Irish	5,473	1,383
Italian (North)	3,832	6,219
Italian (South)	26,710	68,790
Magyar	47	11,377
Mexican	24,796	2,944
Polish	707	12,386
Portuguese	7,440	2,816
Roumanian	237	17,542
Scandinavian (Norwegians, Danes and Swedes)	3,647	2,562
Scotch	6,387	658
Spanish	13,029	3,205
Syrian	708	1,084
Turkish	61	1,258
Other Nationalties	5,174	16,398
Total	136,970	202,808

The Cost of Living

THE cost of living in the United States is still 61.6 per cent higher than it was in July, 1914, according to data gathered by the National Industrial Conference Board (New York).

The figures which are based on retail prices of the component elements in the average family budget show changes during the month of June as follows:

Item of Expenditure	Relative Weight in Budget	Per Cent Increase Between July, 1914, and June	July	Net Change June to July
Food	43.1	45	44	—1
Shelter	17.7	71	77	+6
Clothing	13.2	62	63	+1
Fuel & light	5.6	78	78	0
Sundries	20.4	85	85	0
All items	100.0	61.9	61.6	—0.3

Shelter, it will be noticed, increased 6 per cent, and clothing 1 per cent, while no change is reported for either fuel and light or sundries. Food, on the other hand, is the only item showing a decline, the drop being 1 per cent.

The trend of the cost of living as reported monthly by the Conference Board is shown by curve B of Fig. 3, while the monthly variation in the price of food as re-

ported by the U. S. Bureau of Labor Statistics is given by curve C of the same figure. This latter plotting is of interest, as showing the trend of the cost of living for food is the principal item in the family budget.

As a still further indication of the trend of the cost of living curve A of Fig. 3 is presented. This curve

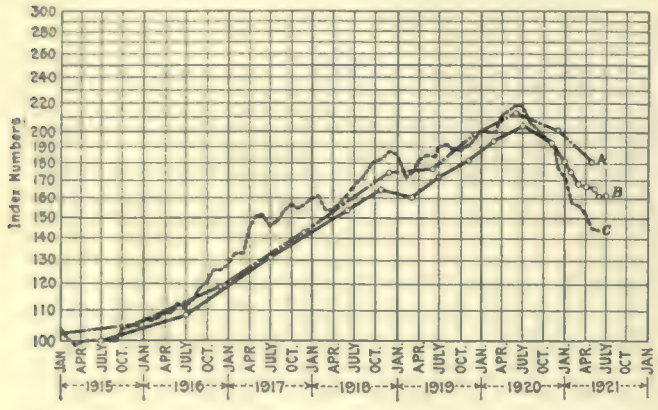

FIG. 3 THE TREND OF THE COST OF LIVING IN THE UNITED STATES

Curve A—Cost of Living as Reported by the U. S. Bureau of Labor Statistics.

Curve B—Cost of Living as Reported by the National Industrial Conference Board.

Curve C—The Retail Price of Food as Reported by the U. S. Bureau of Labor Statistics.

shows the cost of living as reported monthly by the United States Bureau of Labor Statistics, and as will be seen the figures are somewhat higher than those compiled by the National Industrial Conference Board. The data from which this curve is plotted is based upon average prices for the year 1913 as equal 100.

The Trend of Wages

STATISTICS now available for the month of May, or for the period May 15—June 15, show a continuing downward trend in industrial wage rates. An analysis of 1648 May factory reports received by the Chief Statistician of the New York State Department of Labor shows that the earnings of factory workers in that state continued to decline from April through May. The decrease in weekly average earnings during May for the state as a whole was 34 cents, the average earning reported being $25.86. The reduction in weekly earnings since last October is $3.07 or 11 per cent.

Compared with a year ago, the report further states that, the average weekly earning for all manufacturing industries of the state shows a drop of $2.59. Decreases appear in the majority of industries, the largest reductions reported being $12.74 in iron and steel, $10.43 in shipbuilding, and $7.25 in jewelry and silverware. The industries which still show greater earnings than a year ago are railway equipment, fur goods, printing, laundering, bakery goods, confections, beverages, and light and power.

This same trend is shown in the wage changes summarized by the U. S. Bureau of Labor Statistics. In 11 of the 14 industries in which the bureau secures data in regard to employment not only were great reductions reported, but in several cases there was a decrease in earnings for the month of June over the month of May. The following paragraphs summarize a portion of this information:

Iron and Steel. All the men in three establishments were reduced approximately 21 per cent in wages. In 22 plants, wage reductions of 20 per cent were reported, affecting the entire force in 21 plants and 94 per cent of the force in the remaining plant. Eight mills reported a general wage rate cut of 15 per cent. In one concern, the foremen were reduced 16 2/3 per cent in wages while the office force was reduced 10 per cent. A decrease of 11 per cent, affecting 92 per cent of the force, was reported by one plant. In two establishments, a decrease of 10 per cent was made, affecting all employees in one establishment; the number of employees affected in the second establishment was not stated. Payment of time and one-half for overtime after eight hours was discontinued by three concerns. The per capita earnings for June are 12.5 per cent less than those for May.

Automobiles. A wage rate decrease of 10 per cent was reported by three plants, affecting all employees in the first plant, 65 per cent of the employees in the second plant, and 36 per cent of the employees in the third plant. One factory made a 7.2 per cent decrease to 40 per cent of the force. Comparing the per capita earnings for June with those for May, the decrease is 2.5 per cent.

Car Building and Repairing. More time was worked during the pay-roll period and the per capita earnings show an increase of 3.7 per cent for June over May.

Cotton Manufacturing. The wages of all employees in one plant were decreased 8¾ per cent. For June per capita earnings show an increase of one per cent compared with May.

Cotton Finishing. Comparing the per capita earnings for May and June, the increase is 1.8 per cent.

Hosiery and Underwear. An increase of 10 per cent was granted by two mills, affecting 25 per cent of the employees in the first and 2 per cent in the second. A decrease of 22½ per cent was reported by one concern but the number affected was not stated. The entire force of one plant was reduced 10 per cent in wages, while about 66 per cent of the force in another plant was reduced 9½ per cent. An increase of 0.3 per cent is found, comparing per capita earnings for May and June.

Woolen. There were no changes in rates of wages reported for this industry. The per capita earnings show an increase of 1.3 per cent.

Men's Ready-made Clothing. Four per cent of the men in one plant were granted an increase of 10 per cent. All of the men in another plant were decreased 15 per cent. In one establishment, employees earning over $30 per week had wage reductions ranging from 5 per cent to 10 per cent. An increase of 0.3 per cent is shown, when comparing per capita earnings for May and June.

Leather. A decrease of 18 per cent was reported by one tannery but the percentage of employees affected was not stated. Eighty-five per cent of the force in one establishment were reduced 10 per cent in wages. When per capita earnings for June are compared with per capita earnings for May, an increase of 1.5 per cent is disclosed.

Boots and Shoes. An increase of 11 per cent was granted to 3 per cent of the men in one factory. Business conditions have slightly improved and the per capita earnings show an increase of 2.1 per cent.

Paper. In one mill, the shop force was reduced 20 per cent in wages. All employees in another mill had a wage rate reduction of 19 per cent. A 10 per cent decrease was made by one establishment, affecting 83 per cent of the men. Comparing per capita earnings, an increase of 3.5 per cent is shown.

Cigars. A wage rate decrease of about 15 per cent was made to 80 per cent of the men in one factory. A decrease of 10 per cent, affecting shop employees, was reported by one establishment, while 80 per cent of the force in another establishment were reduced 7 per cent. The per capita earnings for June are 0.7 per cent less than those for May.

Industrial Index Numbers

THERE has long been a need for index numbers to show some of the major trends in industry and this need is now to be met by a compilation prepared by the Department of Commerce. The first series of tables have been issued covering monthly relative changes during 1920 and the first five months of 1921. The index numbers are based on data and information which is already available and drawn from three principal sources—government departments, trade associations, and trade journals. The major value in this compilation lies in bringing together scattered figures and compiling them into a usable form, thus permitting interpretations and comparisons.

So far as possible the relative numbers have been calculated by using the average for the year 1913 as a base equal to 100. In many instances, however, the basic data do not go back to pre-war years and in such cases the average for the year 1919 has been used as a base. Also in a few cases still other base years have been used. Wherever a movement can be discerned to be distinctly seasonal an allowance has been made.

The data supplied is divided into ten groups, three of which are presented in the tables below. The six omitted deal with wholesale prices of commodities, transportation, metal ,and metal products, banking, foreign trade movement, farm products, and food stuffs.

TABLE 1. TEXTILES

Source	Department of Agriculture	Department of Commerce					Silk Assn. of America		Department of Commerce		
	Wool						Raw Silk		Cotton		
Year and Month	Consumption 1919=100	Commercial Quarterly June 1919=100	U. S. Gov't Quarterly Stocks June 1919=100	Imports Unmfg. 1913=100	Total Idle Spindles 1913=100	Total Idle Looms 1913=100	Imports to U. S. 1913=100	Storage End Feb. 1920=100	Consumption Feb. 1920=100	Consumption 1913=100	Stocks in Mills 1913=100	Stocks in Warehouse 1913=100
1920 January	126	..	..	258	34	60	51	..	..	121	150	213
March	117	88	46	203	38	64	26	81	91	118	142	183
April	116	..	..	332	28	56	23	68	84	116	139	169
June	81	86	40	130	66	104	34	70	49	114	119	130
July	65	..	..	58	128	160	27	80	36	107	104	116
September	62	83	38	72	141	192	21	79	55	94	69	158
October	67	..	..	53	117	184	16	77	37	82	72	236
December	42	96	34	82	162	200	100	68	31	60	96	318
1921 January	52	..	..	130	190	220	7	49	74	75	98	320
February	110	..	..	264	176	212	24	43	55	81	102	311
March	83	106	34	603	138	172	23	25	85	90	102	296
April	93	..	..	401	93	144	51	31	96	84	101	285
May	..	..	..	91	62	108	46	32	90	90	98	268
June	..	..	..	..	52	88	..	..	..	..	..	..

TABLE 2. FUELS AND POWER

Source	Geological Survey							Standard Oil Bulletin and Oil Gas Journal Geological Survey	
					Crude Petroleum				
Year and Month	Bituminous Coal Production 1913=100	Anthracite Coal Production 1913=100	Beehive Coke Production 1919=100	Crude Petroleum Production 1913=100	Stocks 1913=100	Imports 1913=100	Consumption 1913=100	Producing Oil Wells Completed 1919=100	Electric Power Production of Public Utility Plants 1919=100
1920 January	107	99	121	163	92	429	189	92	119
April	116	82	98	172	90	434	176	120	110
July	121	108	104	185	93	462	206	110	112
October	121	106	126	191	94	775	217	120	116
1921 January	89	123	66	185	102	889	222	105	110
February	70	103	53	171	108	767	178	90	98
March	77	100	36	198	115	829	203	83	..
April	87	105	20	193	120	677	197	70	..
May	93	101	18	198	..	616	..	..	..

TABLE 3. PAPER AND RUBBER
(All figures are based on 1919=100 except those in the last column which are based on 1913=100)

Source	Federal Trade Commission								Department of Commerce
	Newsprint Paper			All Other Paper			Wood Pulp		India Rubber Imports
Year and Month	Production	Shipments	Stocks	Production	Shipments	Stocks	Production	Stocks	
1920 January	113	112	17	130	128	70	107	74	1,837
April	112	117	91	126	121	81	124	77	1,760
July	113	115	92	132	130	69	111	79	1,257
October	109	110	94	124	120	70	113	62	567
1921 January	108	101	135	74	67	101	98	97	744
February	90	84	164	76	71	109	86	104	607
March	94	91	175	83	77	119	93	117	789
April	101	106	147	76	75	120	95	132	722
May	....	....	....	....	....	....	....	....	661

MANAGEMENT ENGINEERING

THE JOURNAL OF PRODUCTION

L. P. ALFORD, *Editor*
E. W. TREE, *Associate Editor*

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The Waste Report

THE special committee appointed by the American Engineering Council to make a study of the elimination of waste in industry has now released its report. Probably no other engineering document has received so much general attention. An abstract of the summary, which was given publicity early in June, had a circulation in newspapers in the United States to over fifteen million copies, exclusive of that in the engineering and technical journals.

Its two major findings are these: The waste in American industry, which is preventable by employing methods already well known, is enormous; the major responsibility and opportunity for eliminating this waste rest upon management.

To one unacquainted with the operation of industry and the possibility for improvement these findings may be astonishing. But they are not to management engineers nor to executives who have made analytical studies in their own plants. Were this not true, the findings of the committee would be less readily accepted. However, many leaders in industry have pointed out as individuals that such wastes did exist and that such responsibility could not be disregarded. So from this point of view the report states, as a result of a new investigation and the mature judgment of a group, what has been previously stated and restated by individuals.

Frederick W. Taylor and Henry L. Gantt, leaders among engineers who have worked to upbuild industry, stand out among all others in the clearness and directness with which they saw these wastes and responsibilities. Gantt's statements are more easily quotable, possibly for the reason that he wrote at a later time when the issues were more clearly drawn under the emphasis of war-time conditions.

In regard to the waste in industry, in an address delivered before the American Academy of Political and Social Science in 1919, he said:

> An analysis of many manufacturing plants indicates that in but a few cases are the machines and equipment in active use more than one-half the working time.

And in a paper delivered before the Southern Commercial Congress in 1918:

> . . . we are getting only 25 per cent effectiveness out of our plants.

Anticipating that finding of the waste report which places the major responsibility upon management, Mr. Gantt wrote in the first paper referred to:

> Throughout our whole system of production there is a tendency to blame the man lower down, rather than the man higher up . . .
>
> The existence of such a condition is not only detrimental to the business system as a whole, but produces great hardships to workmen as individuals.

Already in some quarters objection has been made to the finding of the committee in regard to managerial responsibility. Again, as if anticipating this, the opening paragraphs of this paper of Mr. Gantt's gives a reason:

> In attempting to rate the influence of executives on production, we must recognize the fact that under our present methods executives, as a rule, seem to favor that system of production which to the greatest possible extent relieves them of responsibility.

Consideration of these striking findings must not be permitted to overshadow other parts of the report which are of great importance, for they indicate changes in management practice and labor tactics whereby waste can be eliminated. Among these are: removal of union restrictions; standardization; control of production whereby output satisfies demand and only the essentials in material, time, and human effort are utilized; personnel management whereby the best known methods are employed in selecting, upgrading, and maintaining the working force; conservation of health, life and limb, and opportunity for trade associations and the federal government to encourage and assist in waste elimination and prevention.

These recommendations and others in the report form the outline for a great program.

It is safe to hazard the thought that if this program is undertaken and carried through, the effort will be far more effective in increasing production and in reducing cost than the past attempts to secure efficiency. Moreover, such a program promises to arouse the interest and to secure the co-operation of the workers, for every normal man and woman prefers to do effective work than to follow wasteful practices.

A Tip to the Director of the Budget

AS director of the National Budget, General Dawes will have the enthusiastic support of the engineering profession. In what follows, a suggestion is offered for translating this support into action; and in a direction that might be overlooked without such help as this profession can extend. As public-spirited citizens, engineers at least can indicate how the government's huge industrial establishments should be managed; just as the legal profession might advise in the conduct of the courts and the Department of Justice.

For example, take the situation in the shore establishment of the navy. The costliness of navy yard administration is traditional, and attempts to reorganize

the naval industrial establishment always meet with the approval of the engineers. It is now announced in the papers of July 5, that the professional fighting man, or so-called line officer, is to invade the navy's industrial work still further. It is announced that the Assistant Secretary of the Navy is to have an Aid for navy yards, who is to examine into comparative costs and so on; also that the largest navy yard (at Brooklyn) is to have a manager. Both appointees are line officers. When the reduction of the cost of government is a crying need this information comes as an unpleasant shock.

In seeking to answer this question, we wish it distinctly understood that we hold the professional fighting man in the highest esteem *as a naval officer*. Perhaps we but share the common viewpoint of his fellow citizens when we express a grave doubt as to his capacity as an industrial executive. Otherwise, would not every great civil shipyard and manufacturing plant secure a sea-going admiral or captain as its general manager?

The line seems determined to dominate the navy yards, and for this there must be a reason. Now the commandant of a navy yard is a society personage. So is the captain of the yard, and the manager, not to mention several other officers of the entourage. The commandant has a house, a launch, an automobile, and servants, both military and civil. This is a mild statement of the perquisites that go with the job. Furthermore, all of these things are "maintained" (the technical term used to cover alterations, repairs, renewals, and what not). What applies in the commandant's case applies in less degree to his associates, the official perquisites and privileges of each being appropriately scaled down in true military progression from admiral to captain to commander and so on. The system follows a geometrical progresison, and the tax-paying public foots the bill.

Thus there has been built upon the shore station as a foundation an extensive and expensive social superstructure. The officer on shore is provided with a pleasant resort and a scale of living far beyond anything he would dare attempt from his personal income. But what does this contribute to the efficiency of the navy yard? Something considerably less than nothing It would be cheaper (speaking from the strictly professional viewpoint) to separate such social features from navy yard management. Such separation would have the further advantage of segregating industrial costs from the military overhead.

There seems reason for the belief that there is nothing mysterious about the naval shore station, provided the true facts of the situation are fearlessly and frankly understood. Wherein is running a navy yard, like the one in Brooklyn for example, any different from operating a huge civil shipyard and repair station like Newport News? Perhaps the storehouses are larger and there is a fueling station.

Yet Newport News gets along without an admiral commandant or any professional military establishment. It builds huge battleships, and could repair them if necessary. But suppose a naval vessel in full commission were ordered there for repairs, to whom could the captain report? To the Navy Department, by wire, of course, just as a merchant captain notifies his home office of his arrival. Suppose two ships arrived, who could "co-ordinate" them? Heavens! Did we overlook something? But could not the senior officer present do that much more, in addition to his other duties? Enough of this! There is no reason why navy yard industrial plants should not be managed in the same sensible, business-like way as private plants.

Now, to tip off General Dawes. The books of the navy are kept in considerable detail. In addition to cost figures there are the physical facts, including homes, automobiles, and what not—equipment not needed in operating an industrial plant. All of these are available for inventory purposes. It would be a relatively simple matter to appoint a committee representing The Federated American Engineering Societies chosen from among engineers who are skilled in the analysis of industries requiring managerial reconstruction. This committee could dig up the facts for presentation as a constructive recommendation to the Director of the Budget; and let him do the rest.

Take Heart and Prepare

EMPLOYMENT or personnel departments have been disbanded or curtailed in so many instances during the last six to nine months that this question is forced upon us: Are such departments essential to the carrying on of industry? The occasion for the expansion of employment activities is clearly stated in the opening paragraphs of the discussion by Earl B. Morgan on page 89 of this issue. The mushroom growth which he pictures must inevitably have been followed by a slump.

But what is personnel work anyway. As the situation grows clearer, engineers and executives are declaring that it is "an arm of management" or "an essential function of management." On this point there is already substantial agreement. Therefore, no one need expect or fear a return to the former decentralized employment department, operating outside of and poorly co-ordinated with the production departments. It may be that fewer employment organizations would have been disrupted if they had been established from a knowledge that all they did was but a function of management.

As to the results of such departments there is strong testimony. In the May-June issue of *Personnel*, Eugene G. Grace, President of the Bethlehem Steel Company, sums up his own experience:

> It may be mentioned in this connection that the results accomplished through the work of our employment, medical, and safety departments have been most gratifying through the reduction of labor turnover and the conservation of health and human life among the employees, and we aim constantly to go forward in this work to the end that our plants may furnish safe, healthful, and amicable employment.

In the same publication. Harold S. McCormick, President of the International Harvester Company, declares that industrial relations work pays:

We have found that it pays, and pays well, in mutual satisfaction and production, to give as much and as close attention to the human as to the material side of industry. Careful examination of applicants for employment, with proper registration; competent placement of the new man; cordial and helpful introduction of the man to the job; development from the start of the co-operative spirit, through their works councils or otherwise, to the end that every employee may feel himself a living factor in the enterprise, and may always be sure of a square deal—these, I believe, are a sure means to mutual good-will, to efficiency, economy, and high standards of quality and quantity in production.

Nothing of good is ever permanently lost. There are sufficient facts to prove the good that a properly organized and conducted employment department may render as an aid to the purpose of an industrial plant—production.

Glancing toward the future, labor comes before production. One of these days the thinned-out shop departments must be filled by newly hired employees. The course of wisdom is to perfect the employment organization, either by building anew or restoring as the case may be, and so prepare to raise the standard of the employees both individually and collectively to a higher level.

A preliminary statement of the 1919 census of manufacturers gives the number of industrial establishments in the United States as 288,376. The increase over 1914 is 12,585. A study of details shows that in many of the basic industries there has been little change during the five-year period and, in fact, nearly the entire increase might be accounted for by automobile repair shops, which grew in numbers from 3,273 in 1914 to 15,486 in 1919, or an increase of 12,213. Evidently the small shop is holding its own. The large plants are relatively small in number. The United States Employment Service, which is gathering information from all industrial plants employing normally 500 workers or more, has but 1,424 such plants on its records.

Americans are apt to congratulate themselves over a showing like this, saying that small industry is a national strength. But may it not be a fact that the small shops persist because of the ineffectiveness and wastage in the large ones? If all of the advantages and economies alleged to favor a large plant were made real, what chance would the small shop have to produce anything in competition? As a matter of fact, the small establishments do hold their own and ofttimes produce at considerably lower costs than their overshadowing neighbors.

During the last two years the increase in freight rates has tended to give another advantage to the small concerns. Small shops have been springing up manufacturing woodenware, or milling flour, or producing some other commodity for near-by consumption. Thus the expense of distribution has tended to localize production of some things, as communities find it advantageous to buy first from their own industries and second from those at a greater distance. But whatever the reasons and advantages may be, the small plant seems likely to stay.

BOOK REVIEWS

Management engineering 658

MANHOOD OF HUMANITY

By A. Korzybski

Publisher, E. P. Dutton and Company, New York

REVIEWED BY WALTER N. POLAKOV

Walter N. Polakov and Company, Inc.

ARTHUR J. BALFOUR, speaking of Decadence, said: "Science is the great instrument of social change, all the greater because its object is not change, but knowledge, and its silent appropriation of this dominant function, amid the din of the political and religious strife, is the most vital of all the revolutions which have marked the development of modern civilization." In this sense, Korzybski's new book is revolutionary, or as Prof. Cassius J. Keyser said, in his Phi Beta Kappa oration at Columbia University commencement: "It contains an epoch-making concept." This new concept is a scientific discovery that concerns, most vitally, every engineer dealing with human nature.

The engineering profession today is definitely divided into two groups: Those concerned with research and design, and those concerned with production and service. The difference is radical; while the former act strictly in accordance with the laws of Nature and, therefore, can foretell exactly the performance of the machinery they design before the blue-prints are sent to the shop, the latter are still "guessing," and "hoping," and "feeling," and are of various "opinions" regarding what is "fair" output and what is "just" cause, and what constitute "human" relations in industry. While the method employed by the first group is that of rigorous mathematical thinking over the facts and phenomena scientifically established, the handicap under which the engineers of the second group are laboring is that no laws strictly pertaining to human relations have as yet been discovered and mathematically formulated.

Korzybski's starting point is that the principle of dimensionality is applicable not only to inanimate nature but also to classes of life. The generic concept of dimensionality is mathematically defined thus:

If an assemblage of elements of any given kind whatsoever, geometric or analytic or neither, as points, lines, circles, triangles, numbers, notions, sentiments, hues, tones, be such that, in order to distinguish every element of the assemblage from all the others it is necessary and sufficient to know exactly the independent facts about the element, then the assemblage is said to be n-dimensional in the elements of the given kind.[1]

The elements Korzybski deals with are the classes of life. Applying mathematical analysis, he demonstrates

[1] Cassius J. Keyser, "Human Worth or Rigorous Thinking," p. 104.

that plants, animals, and humans are of different dimensions, because humans possess an additional independent fact which no other class of life possesses, namely, *time-binding* energy which creates history, science, and arts. Men were able to pass on, through generations, their accumulated experience and knowledge, and this time-binding power increases logarithmically with an accelerated rate of acceleration. This natural capacity of man to bind, through the present, the past with the future, is, therefore, the cause and not the result of civilization and progress. Because of it we can induce nature to produce more than it does produce unaided, and this is one of the outstanding facts distinguishing us from animals. Yet, in devising the rules of our conduct and relations, we blundered, inasmuch as we tried to apply the rules observed in the animal life to human relations, thus obviously confusing dimensions and applying rules which, though correct for phenomena of one dimension, were utterly wrong for phenomena of a higher dimension.

The movement known as scientific management for nearly one-quarter of a century attempted to solve the problems of human relations and of increased production, by using the scientific method of induction and experiment, which had produced such gratifying results in all branches of positive science. Yet the results were meager so far as national efficiency is concerned. While one of the causes was discovered and emphasized by Gantt, who pointed out that the aim of our efficiency was to produce dollars and not goods for use, the fundamental question, that is, *why* we tried to produce dollars and not goods, remained unanswered. Korzybski's analysis of dimensionality, which clearly separates the human class of life from the animal kingdom, established at last the fundamental natural law upon which humanity unconsciously labored for some 200 generations. We confused men with animals, while we did not confuse square yards with cubic yards, and because of this confusion, we regarded men as beasts of burden and grew into the habit of measuring their work in horse-powers. This obviously lowered the dimension of human work to an animal level and deprived work of the creative intelligent element, supplanting it by monotonous drudgery.

The book commends itself to any engineering reader, to any man of business, for it points the way out of the welter into which our industrial and social relations apparently have gotten and yet it is not a book suggesting social reforms or any panacea. It is a dispassionate, scientific work, solving the age-old riddle of What is Man, by applying a purely mathematical method of rigorous reasoning. It is significant that the president of the International Rotary Club, Mr. A. F. Sheldon, after studying the book, wrote:

> In my judgment the book is potent with possibilities of being a mighty contributing factor in the restoring of financial equilibrium and economic balance throughout the world, and the bringing about of a status of justice to all parties concerned in industrial and commercial relationships of employee as well as employer.

Indeed, the engineers ought to make this book their Gospel, for it is upon them that rests today the responsibility to shape the social relations and to carry on production for the benefit of Humanity. It is not a theory. It is not a dream. It is a discovery and its irrefutable proof.

Employment management 658.4

PERSONNEL ADMINISTRATION

By Ordway Tead and Henry C. Metcalfe
Publisher, McGraw-Hill Book Company, New York

REVIEWED BY DUDLEY R. KENNEDY
Director of Planning Department, Cluett, Peabody and Company

IT is at best a difficult task to review the work of another, but when the reviewer has been quoted as a reference the task becomes the more embarrassing. To the advanced student of ultra-modern factory practice and management this book is a real delight. The reader not personally acquainted with the authors and their gigantic labors in this comparatively new field will perhaps be less appreciative of the comprehensiveness of the book than one who has made this field his vocation for a number of years.

From the standpoint of the average reader, especially if he be the average executive, the book may be considered both too long and too involved. The very premise from which the subject is taken assumes a knowledge and a sympathy with the broader aspects of this new function which, unfortunately, is not largely held.

It is a pity that a certain group of managers of large businesses have not sympathetically read and acquiesced in the opinions and major principles enunciated in this work. I refer to a large number of executives who for some apparently insincere reason started personnel or industrial relations departments during the "shortage of help" period, only to dispense with or cruelly dismember them when the first signs of business depression loomed on the horizon.

This particular book is subject to the same criticism, and will receive the same criticism, that has come to most of the authors of complete volumes on the subject, i. e., a too social mindedness. While there is no indication of maudlin sentimentalism (indeed the authors make a deliberate disclaimer of the academic point of view) the whole treatment accorded the subject is on a plane too high and too advanced to reach the greatest possible number who sorely need an awakening. There are at least two ways for the author to approach a message such as this; he may start at the beginning and carry his analysis along with the power of absorption of the average reader, or he may definitely pitch it in the higher range and by the strength and reiteration of his assertions endeavor to pull the reader along with him. We are given the impression that the latter course was here pursued.

It is a pity that a number of the real values and benefits of the type of effort espoused appear to many executives as questionable. There is on record or available for reference a pitifully small quota of practically

demonstrated and proved results in definitely designated plants or industries. Certainly this is true if the commonly accepted test of "How much will it make for me?" be applied.

Any author approaching the same subject is handicapped by the paucity of concrete result references. Those personnel executives who have achieved the most patent and emphatic results are subject to a too pronounced modesty, not only regarding the results themselves, but regarding their own ability to put these results into the form of text for those who wish more of the concrete illustration. This fact should not by any inference detract from the credit and appreciation due to these and other authors who have the courage of their convictions, and thoroughly believe in the righteousness and business sagacity of a real plan of industrial relations, but rather should it add to the credit due them.

This form of review should in no sense be accounted an attempt to justify this text. It needs none. The man who wishes to read only that with which he can absolutely agree, will probably not read far into this book, anyway. If we mistake not, this work is intended to provoke discussion and constructive thinking. Perhaps many of the executives commonly referred to as ultra conservatives will take exception to much that is here proposed, but by the same token perhaps some may be influenced to give more heed to a coming ground-swell of public opinion.

These authors believe in their message and have written a symposium which will make many a reader lay it down with violent disapproval, only to reach out for it again, curious to know how far the application of the Golden Rule is to be carried in the administration of modern business enterprises by the advanced thinkers.

It would be a better book and would more amply fulfil its mission if it contained more of the "How" to accomplish the desired results. It is the best that we have yet seen in its exposition of the "Why." No employer of labor who makes any pretense of keeping abreast of current literature on this and kindred subjects can afford to admit that he has not read it through.

Employment management *658.4*

EMPLOYMENT METHODS

By Nathan W. Shefferman

Publisher, The Ronald Press Company, New York

REVIEWED BY EARL B. MORGAN

Director, Employment and Service Department, The Curtis Publishing Company

ONE of the outstanding characteristics of the men who are actively engaged in the development of personnel work is their willingness to make public the results of their experience, and this characteristic has probably had a dominant influence in encouraging rapid development in the field. Mr. Shefferman, in presenting his book, seems to be prompted by such a desire, for, he says, he wishes "to tell of what has been developed or discovered in recent years." In fact, one finds in looking over the book that it is, as intended, a general survey of the field—a compilation of the best practices based on actual observation and experience.

In the first chapter the "Reasons for the Employment Department" are definitely set forth in a somewhat novel manner, but perhaps the reasons given are not quite so thorough and convincing as might have been possible in handling such an important phase of the subject. In discussing the "Function of the Employment Department" the author sets down in excellent and concise fashion a statement of the broad conception of employment work. A strong feature of the book is found in the charts which are presented, especially the chart portraying all the functions falling within the scope of the employment or personnel manager. This is an excellent piece of work and deserves particular commendation.

However, in a fashion somewhat characteristic of other works on employment, the author treats the important subject of interviewing rather meagerly. Attention is caught by the auspicious beginning of the discussion on this subject with the statement that interviewing is the most important function of the employment manager, but there the matter is left hanging. The author seems to advocate the cross-question method of interviewing, which is not quite up to the modern practice of developing a friendly conversation, so directed as to bring out the qualifications of the applicant.

In the exhaustive treatment of forms one is particularly impressed by the complicated nature and the design of the forms given. A superfluous amount of detail, however, is contained in each form, and far more forms are suggested than is absolutely necessary. The monthly labor turnover record form which is exhibited is very good indeed.

Frequently throughout the book overemphasis is placed on the old idea that the sole objective of the employment manager is that of minimizing labor turnover—not that this is not an important objective—but there are far too many employment managers who have this as their *sole* objective, and do not appreciate the fact that there is economical turnover just as well as uneconomical turnover. In other words, by this overemphasis there is danger of overencouraging the tendency of employment managers to become "labor turnover hounds."

A broad attitude is taken in regard to the use of various forms of tests, and the author very properly warns against making a hobby of these methods. He rather advocates being familiar with them in order to build up, on the foundation of experience, an ability to select applicants.

This is the first work in which such a thorough presentation of identification systems has been made, and it constitutes a very valuable contribution to the subject of employment management.

The author seems to differentiate, for some unknown reason, between methods which should be used for the so-called shop-hiring as contrasted with hiring for offices and business houses, with the result that there is much duplication which could be eliminated if the whole subject were treated together as it should be.

The "Women in Personnel Work" discussion is very timely and instructive and handles a new subject in an interesting way.

Enough excellent material is presented on the subject of "Industrial Housing" to thoroughly familiarize the uninitiated with the fundamentals of the problem.

In the appendices are some very complete and valuable discussions on such subjects as "Employees' Hand Books," "Industrial Training," "Americanism," "Visiting Nurses," "Suggestion Systems," and "Health Departments," all of which are exhibits of actual experience by well-known companies.

There is really nothing new in the book, nor did the author intend that there should be. He rather seems to have set himself the task of presenting a thorough survey of good employment practices in their broadest ramifications. "Employment Methods," accordingly, is one of the most complete books on the subject published to date. It would seem, perhaps, to appeal to the man just entering the field rather than to the experienced man, but even the latter could well afford to have the work on his shelves as an encyclopedia for reference from time to time.

Management engineering 658

THE MODERN FOREMAN

By Robert Grimshaw

Publisher, The Biddle Publishing Company, New York

REVIEWED BY W. L. ALBRO

Industrial Relations Section, General Motors Corporation

IN "The Modern Foreman" Mr. Grimshaw has given to the industrial world one of the most needed works of the age. Not only foremen, but all employers of labor and those who supervise their activities will profit by reading and consistent studying of this book. Furthermore, after reading the book it will be apparent to the progressive that they have found the real reference book that has so long been sought.

The author has realized the want of our handlers of men, materials, and machines. He has stated the fundamentals in a straightforward manner and eliminated the non-essential. At times he is a bit severe, but the frankness of expression nullifies the possible offense. There is a challenge offered throughout the book that demands acceptance.

Paramount above all other things, however, is the fact that the author has avoided the common mistake of trying to teach the technical details of operating the machine shop, the paint shop, or the trim shop. He has built his work around the several M's, as he has termed them. Included in this are money, men, management, machines, materials, etc., making a most interesting, as well as constructive story. The style of expression is simple enough to be readily understood, yet it is technical enough to lend dignity to the work.

Management engineering 658

FACTORY ORGANIZATION AND ADMINISTRATION

By Hugo Diemer

Publisher, McGraw-Hill Book Company, New York

REVIEWED BY L. P. ALFORD

THIS is the third edition of a book written to meet the needs of executives in manufacturing plants, particularly those in contact with the problems of production. Its background is twenty years of experience, partly as an employee and partly as a consulting engineer.

In treatment it begins with the principles of management and builds thereon the methods followed in financing an industrial corporation, in setting up its organization and establishing the systems of factory accounts and department reports. Two chapters are then given over to the factory site, planning the buildings and indicating the influence of design on productive plant capacity.

Ten chapters are devoted to specific departments, and several others interspersed throughout this group touch upon specific parts of operating details as the one devoted to bills of material, another to foundry systems, and still another to time taking. Closing chapters deal with such matters as the inventory inspection, rate fixing and time studies, and wage systems. The final chapter turns again to the matter of management principles, amplifying by illustrations the fundamentals presented in the opening.

This new edition differs from its predecessors in modifications made necessary to conform what is presented to the evolution of management practice and standards. The major changes have been made in those chapters dealing with general organization with the personnel department, including employment and industrial relations, and with the functional control of production. Throughout the other chapters minor changes have been made to conform to current methods and practice.

The personnel department is shown as a development of the former "Hiring Office" into an important factor in general factory management. Under the head of its activities are grouped the preparation aspect of managership, including selection, placement, training, physical and mental hygiene, and services to employee intended to develop and maintain the morale or spirit of the organization. A number of forms indicate the nature of the records which should be kept in a personnel department. A feature of this chapter, as of all others in the book, is a list of references to permanent literature on the subject.

All the new and expanded chapters are treated in

much this same manner, having in view the needs of the executive in manufacturing as well as the student of management or production.

Engineering bibliography *016.62*

THE ENGINEERING INDEX, 1920

Publisher, The American Society of Mechanical Engineers

THE second volume of *The Engineering Index* to be published by The American Society of Mechanical Engineering has just been issued. It is a book of 586 pages, containing nearly 14,000 items referring to articles in some 700 engineering and allied technical publications, which are printed in some 10 different languages. It is thus the most complete reference work of its kind published.

The Engineering Index was acquired by The American Society of Mechanical Engineers at the close of 1918, and combined with the Selected Titles of Engineering Articles then appearing in the society's monthly journal, *Mechanical Engineering.* It is a continuation of a work started in 1884, when Prof. J. B. Johnson, of Washington University, began to regularly index for the Journal of the Association of Engineering Societies the articles appearing in the leading current periodicals of that time. The undertaking proved highly successful, and at the end of five years Professor Johnson compiled and published the first volume. In 1895 the second volume was published, and from then on, until the close of 1918, *The Engineering Index* has been published annually.

The index is a regular feature of *Mechanical Engineering,* the journal of The American Society of Mechanical Engineers's monthly publication, in which references to articles appearing since the close of 1920 may be found.

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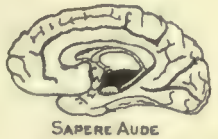

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MANAGEMENT ENGINEERING

THE JOURNAL OF PRODUCTION

VOLUME I SEPTEMBER, 1921 NUMBER 3

Weights and Measures. Management *658: 389*

The Essentials of Weighing in Industry

Adequate and Accurate Equipment, Proper Maintenance, and Intelligent Use the Basis of Good Practice

By HERBERT T. WADE

THE accurate determination and knowledge of quantities is obviously essential wherever civilized man seeks to engage in manufacturing, construction, or commerce. Indeed so commonplace is the matter that it is only the most enlightened who have given heed to it, and like most subjects connected with the science and art of measurement generally, an author at the very outset has to challenge interest in the subject itself before he can secure an audience.

The even arm balance dating back to a respectable antiquity in Egypt, the steelyard of the Romans, the balances and scales seen about us on every hand, have been and are accepted as a part of our daily life. But here is just the point; the weighing and the balance and the scale are so accepted, and accepted without thought, not only by the general run of people but even by otherwise careful engineers and business men, that a serious attempt should be made to make clear and understandable just what is involved in weighing and how important this fundamental process is in commerce and industry.

Of course, in the determination of the quantity of a commodity, or in ascertaining or stating its amount or size, its mass or weight is its predominating characteristic, and even in the Anglo-Saxon system of weights and measures where measures of volume have figured for centuries, there has been a well-defined tendency to substitute wherever possible mass or weight measurement for measures of capacity or volume. Today a bushel of wheat is not the amount equivalent to a volume of 2150.42 cu. in. but is 60 lb., and around commercial grain weighing much controversy centers.

ERRORS IN WEIGHING INVOLVE THE GROSS

We start with the scale as the meter of all the raw materials entering a plant or process, we use it as a check or measure of the compounding, treatment, or other development of such materials, and finally as a measure, either direct or indirect, of the product thus developed. But always the scale measures the gross, not the net, which must be obtained by simple calculation or a mechanical device. Thus scale or weighing errors involve the gross or total price not merely the net or profit; and a scale error where goods are bought or sold by weight is a tax on the gross business, not merely on the profits. For example, a scale may weigh light, that is the actual quantity delivered is in excess by 1 per cent, and this is not at all uncommon, yet the actual result is that the seller voluntarily taxes or assesses himself by an amount equal to the proposed sales tax which has been discussed as a revenue measure. If his profit is 10 per cent an overweight of 1 per cent represents 10 per cent of that profit.

THE DEPENDENCE OF INDUSTRY UPON WEIGHING

Accurate weighing and good scales insure that excess is not given for good measure. There is also another aspect of the matter, namely, that a manufacturer is continually selling to himself over his own scales. The supplies sent out from the supply yard, warehouse, or storesroom are in excess or deficiency by as much as the scales are in error or lacking in sensitiveness.

No more striking example of the fundamental importance of correct weighing is found than in the simple and usual relation where a charge or value is obtained by multiplying a weight by a unit price or rate. What avails a satisfactory price or rate if the determination of the quantity is in error or uncertain? Both factors in the equation are of equal importance; one, the unit price, is fixed arbitrarily, but the other, the weight or quantity, is capable of accurate determination only if the right men, measures, and machines are employed. In American transportation the entire return from the transportation of freight is on a weight basis, and as has been aptly said "the scale always draws a defining line between the shipper's money and the railroad corporation's money. The more accurate the scale, the more closely is the dividing line drawn."

Likewise in mining, from the wages paid for cutting or excavating the coal to its delivery to the consumer, weight is the primary element after quality, yet, as we shall find, its determination is far from accurate and leads to continuous misunderstanding and controversy at almost every stage. For example, in 1919 the United States Bureau of Standards found an average error of 6 per cent in scales it examined in certain coal mines in Maryland. These same scales determined the coal, or other commodities are weighed automatically as a part of a conveying or packing process, the determination of weight involves a greater or less amount of time and is an incident of one or more stages of a continuous process. In modern industrial operation any agency that interrupts direct flow or routing must have a reason, in other words it must be necessary; and secondly, such necessary interruption not only must be as brief as possible and not tend to dislocate the reg-

Features and Advantages of Good Weighing Practice and Equipment		Defects and Disadvantages of Inaccurate and Inadequate Weighing Equipment	
Basis of Good Weighing Practice	Essential Elements in Securing Good Weighing Equipment	Faults in Weighing Practice Due to	Results of Poor Weighing Practice
Adequate and accurate equipment.	Survey of plant or process to determine where weighing can be done with advantage.	Failure to realize nature and importance of weighing.	Various wastes in process.
Proper and intelligent maintenance and supervision.	Study of weighing problems at points thus determined to ascertain types and number of scales required.	Apparatus not properly designed or built for work in hand.	Losses due to errors and controversies over quantities in invoices and shipping bills.
Frequent and careful inspection and test of scales and weighers both by plant officers and outside experts.	Preparation of tentative and informal specifications for such equipment put in final form after—	Scales deficient in strength and capacity, or lacking in sensitivity.	Overweight to purchasers at expense of enterprise.
Care in operating, reading, and recording.	Investigation of standard commercial types available.	Bad installation.	Inaccuracies in receipt and issue of materials and stores.
Intelligent systems of recording weighing data and results.	Sufficient appropriations for *best* scale for particular purpose, not the cheapest.	Scales improperly sealed and inaccurate counterpose weights.	Inaccurate data for cost accounting.
Maintaining purchase, service, and performance records of all scales and weights.	Installation on proper foundations by qualified scale mechanics.	Deterioration of scales due to use and abuse, and bad adjustment.	Lack of accurate control of process.
	Acceptance tests of scales and weights against official or certified standards.	Carelessness, haste, and ignorance of weighing.	Undue amount of time consumed in weighing and bad routing and failure to coordinate weighing with general flow of progress.

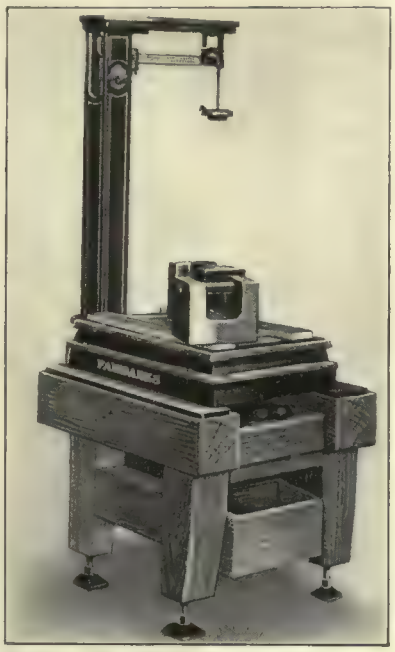
miners' wages. In fact where scales weigh labor, as do the mine scales, an equitable arrangement would provide that the tolerance or permissible error should not exceed 0.4 per cent with the existing scale of wages. A second inspection of the scales referred to above after they had been adjusted and repaired showed but 0.17 per cent average error.

Within a manufacturing plant weighing is intimately involved in the internal economy and, as an essential element, enters into the management and accounting, through inventories, control of processes, checking, cost analyses, etc. As it is most essential, it should be done efficiently and economically, and within readily defined limits of accuracy, for on the weights returned by the scales the costs are determined, and on them are based the profits and selling prices.

Now with a few important exceptions as where grain, ular procedure, but in such cutting down of time and securing convenience there must not be any sacrifice of the primary object of the weighing, namely, a result of the required accuracy.

The first consideration is the degree of accuracy essential and this depends primarily on the value of the material and its purpose, as for example, a small yet accurately proportioned amount of a cheap substance might be required for an important compound. To take a rather exaggerated example: it will be admitted that too much care cannot be exercised in selecting the balance and weights with which diamonds or platinum, or other precious or semiprecious metals such as tungsten filaments are weighed and in supervising the weighing. The cost of a balance and standard weights is a secondary matter, and if it weighs rapidly at the expense of accuracy it is manifestly inefficient for its purpose.

On the other hand dealing with a bulk commodity such as coal, iron ore, sugar, grain, etc., it must be realized that high precision means the use of a delicate and sharp scale subject to wear and deterioration in its accuracy, the employment of careful and highly trained weighmen, and a considerable time for each weighing as an accurate scale is apt to be slow.



Courtesy, The Fairbanks Company

FIG. 1 SEALING A PLATFORM SCALE

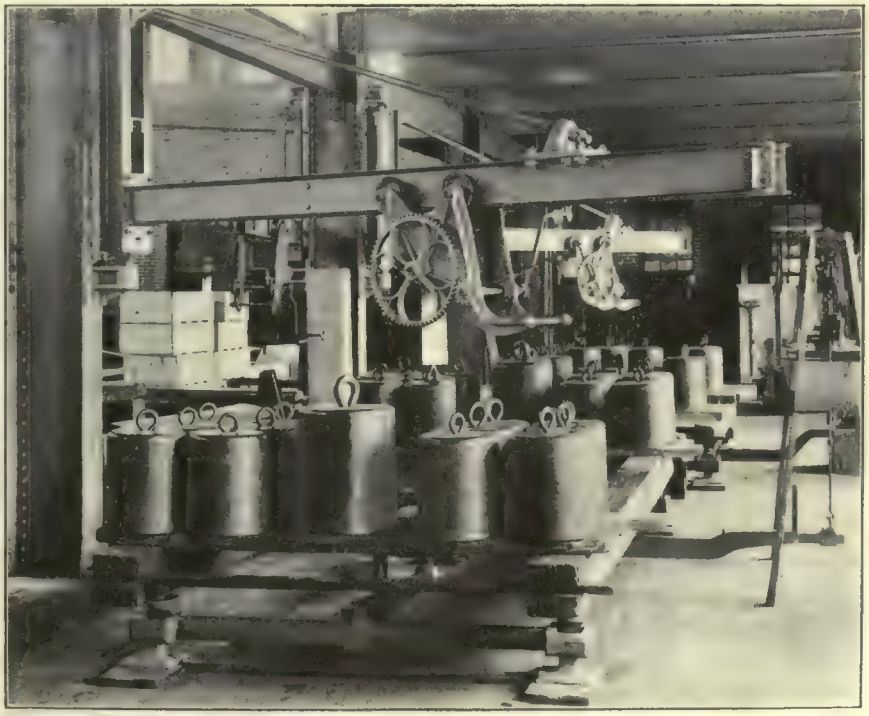
The final adjustment of a scale is with standard cast-iron weights (usually 50 lb.) on the platform at different positions. The scale should indicate correctly the load. This is the usual method employed for acceptance test and in regular routine of maintenance.

But the fact stands out, that not only is the material of small value in comparison with any *extensive* costs of extensive handling, but it is not constant in weight on account of its moisture content, foreign material accumulated in its transportation and transfer, loss incident to travel and transportation, and other causes. On this account it is neither desirable nor worth while to secure greater accuracy in a single weighing operation at the cost of equipment, labor, and time, all reducible to a cash basis, to any greater degree than within the limits of these and other variable conditions, so long as the material is handled under the most practical conditions of commercial efficiency. Yet fine material must be weighed with care and intelligence and on a scale of sensitiveness and precision. The practical way is to set a permissible tolerance or standard in each special weighing process and then secure or adjust equipment to meet that standard in the most satisfactory and efficient way possible with due regard, of course, to economy of time and labor.

What are reasonable tolerances can be seen from tables compiled for different types of scales and counterpoise weights adopted by the Eleventh Annual Conference on the Weights and Measures of the United States and recommended by the United States Bureau of Standards for state adoption. These can be compared with the work in hand and the fact determined as to whether or not they apply. For example, when the tolerance maintained is about 1/10 of 1 per cent, the scale probably possesses a satisfactory accuracy for material that is valued at less than 20 cents a lb. for most operations.

Providing necessary strength for a scale has been one of rather recent development, since it has been realized that the capacity of a scale was not the extent of the beam graduations and the number of counterpoise weights supplied, but was conditioned by its structural strength. An essential requisite for accuracy is that the scale shall have sufficient strength to support the greatest loads placed upon it without deflection of the lever system or change in the relative positions or alignment of the knife edges, loops, and bearings.

Increased loading all along the line from the railway locomotive of great size and the heavier capacity freight cars, especially for coal and ore, as well as the trucks used within industrial plants and the motor trucks of even greater weight and capacity, have



Courtesy, The Howe Scale Company

FIG. 2 CAPACITY TESTING OF AUTO-TRUCK SCALES

Sealing room, showing actual test with heavy standard weights approximating service conditions. Truck scales are called upon for ever increasing weights of trucks and loading concentrated usually on rear axle. Such scales should be tested to capacity before acceptance and periodically while in service. The scale shown under test is of the ball-bearing pipe-lever auto-truck type built for 10 to 30 tons capacity.

brought to the scale manufacturers the important structural problem of developing ample strength and rigidity, at the same time securing a mechanism which in addition to being strong and durable would function with sensitiveness and accuracy. This was especially true for the track scale, but the development of the motor truck brought important problems of design, construction, and use, for not only were the axle loads heavier, but there was an uneven concentration on the wheel base with the rear wheels carrying the bulk of the load, so that if a wagon scale had a rated capacity for a horse-drawn wagon equal to the weight of a motor truck and load, which rarely was the case, it did not signify that it could either support or weigh properly when the load was concentrated over one set of sections. In fact a wagon scale is safe for a motor truck only to about 50 per cent of its rated capacity.

Courtesy, The Strait Scale Company

FIG. 3 A PORTABLE PLATE MILL SCALE FOR ROLLING MILLS

A typical rough service industrial scale strong enough to resist the impact of heavy falling plates. Beam equipment consists of full capacity beam with fractional beam reading to 1 lb. without counterweights, mounted in a sturdy structural steel frame to protect lever mechanism. The scale has a capacity of 6,000 lb.

There are so many sizes and types of scales that usually there is little difficulty in securing one adapted to the special purpose in hand, on the basis of the general considerations already discussed. In addition it must be remembered that, in the smaller sizes at least, the original cost of a scale is so little in comparison with its usefulness and importance that it is good economy to secure exactly the type and quality needed, and it is better to have two or more scales each adapted for a special function or range, than to have one of considerable range but less efficient for at least one class of duty.

Facility of operation and ease and speed of reading usually are secured by using the appropriate device, and particularly under modern conditions some special automatic or indicating scale. Such a device, generally speaking, involves not only a gain in time with adequate accuracy if proper scales are selected and due precautions are taken, but also an important gain in efficiency, as it may be possible to eliminate at least the weighman by the use of a dial or indicating or recording scale. There is, of course, no more satisfactory or accurate weighing machine than a beam-scale with a poise adjusted by hand by a skilful weighman, yet there is involved a loss of time for such adjustment and the coming to rest of the beam, a loss which is shared not

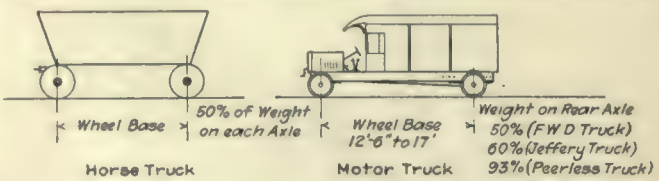


FIG. 4 COMPARISON OF WAGON AND MOTOR TRUCK SCALE LOADING

only by the scale and the weighman, but by the trucker and truck, and by the recorder or freight clerk. Given a proper dial scale or indicating or autographic device, types of which are available for use with a good beam-scale already installed, the weight is secured at once without the services of a weighman and the record if not registered on a ticket can be promptly made.

The diagram of Fig. 5, plotted from data compiled by Dr. F. Reichmann, while Superintendent of Weights and Measures of the State of New York, shows in graphic form the difference between a poor and a good scale as used in a coal-yard, though of course the same conditions apply elsewhere. The coal-yard scales were taken for analysis as their accuracy vitally affects the business. The poor scale was a shallow pit scale of from 6 to 8 tons capacity, and in error by about 5 lb. when purchased, and this was about as good as it could do at its best. This zero error gradually increased as shown by the curve *A C*, until after two years and three

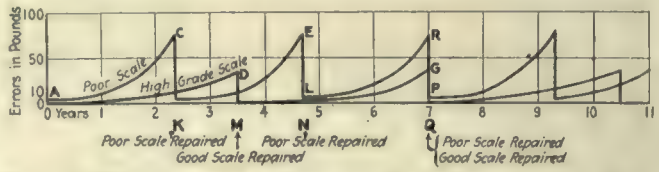


FIG. 5 COMPARISON OF A POOR AND GOOD SCALE IN COAL-YARD SERVICE

Poor Scale—6-8-ton shallow pit type or light scale of greater capacity.

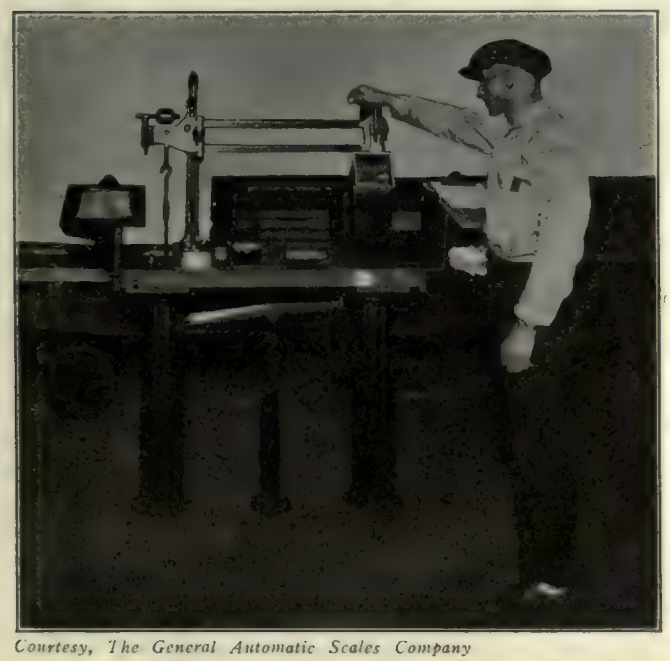
Good Scale—20-ton motor truck type of heavy construction with suspended bearings.

months of service it amounted to 75 lb., an amount far in excess of any reasonable tolerance and against the interest of the owner as the scale was weighing light. At the time the condition was realized, the scale was sent to the repair shop to be brought back to normal, and at the best the same condition, if not worse, would develop in the same length of time. Now a good quality scale, say a 20-ton auto-truck scale with suspension bearings and adequate strength, is secured which is correct at the outset, but with use error develops, as shown by the curve *O D*. However, it will be three-and-a-half years before this amounts to 25 lb., and as this scale is considered more accurate it goes to the shop much earlier. The curve *O D* is for a good scale

that receives little, if any, intelligent care, and the error shown could be reduced by periodic inspection. However, where the poor scale goes to the shop and is out of commission three times in a given interval, the good one is repaired only twice, and the relative errors only have to be considered in view of the business done to show the cost of the poor equipment. Dr. Reichmann computed that for a small coal-yard a high-grade scale with proper care saved almost one-half over a similar scale without such attention, while counting interest and depreciation, care and maintenance, and the probable losses on sales due to scale errors in 5 years the high-grade scale well maintained cost but about 25 per cent of the cheap scale neglected and about 40 per cent of a cheap scale given proper care. Furthermore, the high-grade scale had a capacity up to 20 tons with naturally far greater strength and durability.

Scales not only must be purchased, but must be installed also with knowledge, intelligence, and care on adequate foundations by efficient scale mechanics.

After proper types of scales have been acquired, the next consideration is their convenient location, at or near the point of use, though portable scales may be moved as and where needed. Compared with the cost of labor and time in going out of the way to reach a scale, to wait for one used by others, or to have it placed



Courtesy, The General Automatic Scales Company

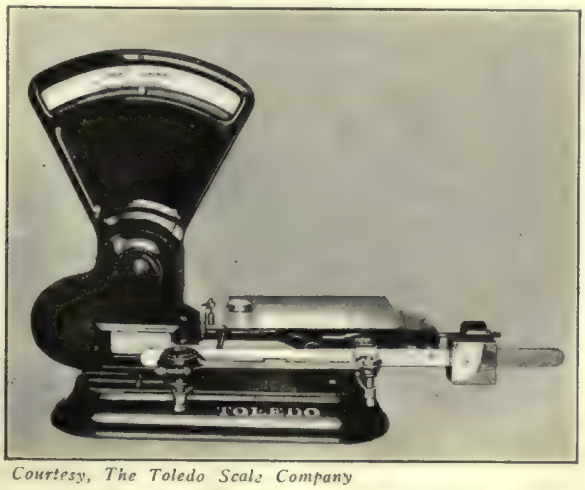
FIG. 6 A DORMANT PLATFORM SCALE EQUIPPED WITH WEIGHTOGRAPH

The weightograph is an optical indicating device at the beam designed to show by illuminated figures the weight on the platform.

at a level or at a distance inconvenient to the work being weighed, the cost of a new scale is often but trifling.

Instead of regarding the scales as devices of infallible accuracy when received from a maker of acknowledged reputation, heaven-sent as it were, and maintained by some mysterious means in the same infallible accuracy under all kinds of use and abuse, not to mention neglect, it must be borne in upon every user of scales that accuracy in weighing and real economy in the procurement and maintenance of scales and other weighing machines can be secured only by intelligence and eternal vigilance, for which provision must be made in the organization.

For obvious reasons the moving parts of a scale are to a large degree usually enclosed and as a result they are forgotten. But while they are out of sight, yet ac-



Courtesy, The Toledo Scale Company

FIG. 7 A SPECIAL INDICATING SCALE

This scale is designed for use in the manufacture of connecting rods for automobile or airplane engines. It determines the total weight of the rod and the amount by which it differs from the standard, and by means of the auxiliary beam distribution of the weight of the rod and the position of the center of mass is determined as well as the deviation, if any, from the standard.

cess is afforded to dirt, dust, dampness, and fumes, and moving parts may be clogged, steel knife edges or bearing surfaces corroded or otherwise damaged from shock, jar, or other careless treatment. Still the scale beam moves and seems to balance, and even though it be sluggish little heed is paid to it, as it is assumed that the scale weighs.

Furthermore, scales fail to receive even the most elemental cleaning or oiling, notwithstanding the very patent fact that dirt around the knife edges destroys sensitiveness, and while they are assumed to be of robust construction and are able to withstand rough treatment as well as to support overloads, yet usually there is no disposition to give them the same attention as other machines with moving parts and fine bearings require and receive. Often it is not even realized that the knife edges of a scale are growing dull and need attention or that other parts are out of adjustment, for it is believed by many that a scale, like a king, can do no wrong, and this feeling may persist until the fallacy is demonstrated by painful and costly experience, for a worn or dull scale usually weighs against its user.

Of course there are manufacturers with well-organized and efficiently functioning departments of weights and measures. The great steel works are now equipped with good scales and well-organized inspection departments. Other metallurgical industries have given the matter attention, and naturally careful weighing is essential in plants whose product, such as food and drug articles or commodities, must comply with statutes as to marked or net weight with considerable accuracy and

under certain penalties. There are other commodities packed and merchandised on a basis of weight, and while a small overweight may be of slight importance in a single package, it becomes very appreciable when multiplied by 1,000 or 10,000. On the other hand, the purchaser suffers through any short weight, and if such deficiency is habitual and becomes generally known, the reputations of both the article and its maker are bound to suffer.

Not only the packing but the transfer of commodities and their weighing in the course of such a process also presents another important consideration, for bulk weighing, while it involves the handling of large amounts of material of comparatively low unit cost, nevertheless deals with the fundamental considerations of weight which underlie all commerce and industry. The determination of quantities of coal, grain, and other universal commodities, is the basis of trade, and the accuracy of such quantities must be established from the point of production to the place of consumption. Not only trade, but the equally important matter of transportation and transportation charges is concerned, as well as the actual utilization of the commodity. The utilization of fuel in a plant should be based on discriminating economy, and sound policy and good industrial management and today demands the use of various automatic bunker and furnace scales for determining and analyzing the consumption of fuel.

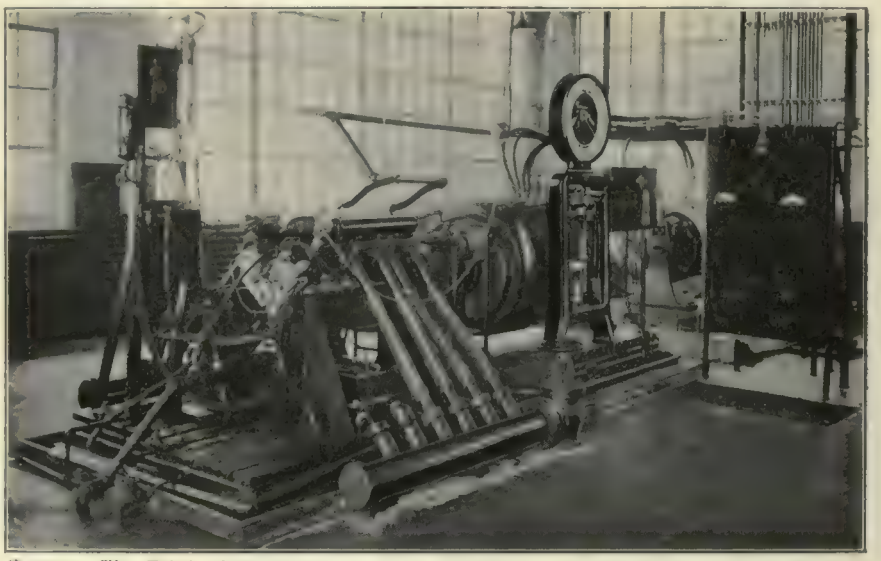
Different and special forms of scales, so many in fact that each industry may be said to have its own special types for special purposes, develop in convenient and direct-reading form once a weighing operation becomes a standardized routine.

An Example of Routine Weighing

As typical of modern tendency in efficient weighing one might cite a scheme recently developed for the packing industry where the carcasses of sheep, mutton, calves, or beeves are loaded into refrigerator cars from the packing-house. The dressed meat comes down on a trolley and passes over an indicating and recording scale, where a weight ticket is printed in triplicate. Of the three copies one is immediately affixed to the animal as it leaves the scales while the others form the basis of the shippers' and carriers' weights and charges. It does not require much imagination to see the possibilities of such a device or combination with a numbering and adding machine to have an autographic record of the total business passing over such scales.

It is possible to measure directly other forces, as those of traction, torque, or friction, and for such work there is employed the dynamometer. These determinations of force, whether the thrust of an airplane propeller, or the pull of a locomotive or motor car, all are measured with some form of scale or equipment in what is essentially a weighing device with known or standard weights as the fundamental elements. Usually a weighing machine with any desired modifications is designed for the special testing work contemplated in such form as to secure accuracy, range, and convenience of use and reading. Naturally there is a wide variety of such instruments.

Consequently any improvement in scales and weighing equipment, generally, that secures greater convenience and accuracy affects a wide range of measurement and testing, which finds considerable industrial and commercial practice as well as application in the laboratory. Take, for example, the case of measuring the horsepower of a motor vehicle engine as developed in the torque of the main crankshaft. Here by a special form of direct-reading scale it is possible to read off at once from a dial the horsepower under different speeds and under different conditions of feed and carburetor adjustment, different systems of cooling or different fuels, in fact under any of a number of varied conditions. The actual pull of a motor car is measured by a dynamometer as well as the effect of the brake. Typical of a special weighing device is a scale which not only weighs a connecting rod but determines the distribution of the weight as regards its configuration and the location of its center of gravity. The utility of this device will appear when it is stated that an uneven or faulty distribution of weight in a connecting rod designed for perfect balance will seriously affect the operation of a high-speed engine.



Courtesy, The Toledo Scale Company

FIG. 8 A DIRECT-READING INDICATING SCALE USED IN CONJUNCTION WITH A DYNAMOMETER

The above uses of modern scales are typical and suggestive rather than comprehensive, but they indicate in how many ways weight measurements may figure, and what is of particular interest these tests often can be made without the special manipulation and technique of the laboratory but with ordinary commercial and direct-reading instruments which can be used by those directly concerned either in the actual production of the machines or parts in the ordinary routine tests of the plant or department.

Waste in the Metal Trades Industry

An Abstract of a Field Report Based on Studies in Sixteen Representative Plants

By FRED J. MILLER

Consulting Industrial Engineer

A section of the complete report on the elimination of waste in industry, prepared by a special committee of the American Engineering Council,[1] consists of six intensive investigations into leading industries. One of these was based on a study of metal trades plants mainly engaged in building machinery, and this report is presented below in abstract form, little being omitted, however, except matter of an explanatory nature. In conducting the investigations and in preparing the complete report for the committee, Mr. Miller was assisted by Mr. William B. Ferguson.

A STUDY of the metal trades industry and comparison of the factors of waste, or causes of non-production in various representative plants in that industry, lead to the conclusion that, at a conservative estimate, the value of increased production possible in the United States would be over half a billion dollars annually—even in normal times.

At the present time, due to the large unemployment of available men and machinery, the waste is nearer to a billion dollars a year. This estimate covers the value of labor only and does not include the value of materials that would be utilized if the productivity of labor were increased.

Views of Executives in the Industry

Before giving conclusions as to the major causes of the above-mentioned waste, we present the views of some of the managing executives themselves in 32 of the plants visited. Being asked their opinion as to the main cause of waste or inefficiency their answers were as follows:

In eight plants the answer referred particularly to present business conditions and was to the effect that "the most important cause is the uneven volume of business or the fluctuation in the demand for the product; lack of enough business to keep going at normal capacity."

In four plants the cause given concerned the railroad situation and the functioning of the Railroad Adjustment Board.

In three plants the cause given was "lack of standardization of design of products."

In two plants the cause given was "labor turnover and strikes," one executive saying that these had been caused by war time conditions.

In four plants the cause given was "lack of planning"—the exact words used being "lack of proper planning and routing;" "lack of correct planning and material control;" "unscientific planning and management;" and "lack of efficient planning and management methods."

In six plants the cause given was "lack of co-operation between management and labor." Other causes given in various plants were as follows: "Lack of intensive study of methods;" "cost control systems needed;" "daily cost reports needed;" "lack of scientific management applied to all phases of the business;" "inefficiency of labor and excessive overhead."

In other plants special causes in the machine tool business were given as follows:

1. "The failure of machine tool builders to supply what the public wants."
2. "Most of the metal trades shops are very small and require personal handling by the manager of such important problems as are handled by our system of production control."
3. "Insufficient capital to develop sales and to improve facilities."
4. "Purchasing in small quantities, by the small plants, which places them at a disadvantage as to favorable prices and as to transportation and handling evpense."

The major cause of waste or non-production in the metal trades industry at the present time is the unemployment of available labor and equipment, due to general business conditions. The industry as a whole is operating at only about 60 per cent of normal output. Manufacturers can undoubtedly hasten a return to normal conditions by producing goods as economically as possible, thus being able to make selling prices low enough to be attractive to buyers.

The Fifteen Plants Studied

A comprehensive study and survey has been made of 15 representative plants, of various sizes and types, distributed through the states which lead in the industry. In addition to these detailed surveys or assays, a number of other plants were studied, and general information obtained through the co-operation of various metal trades associations. Altogether the investigation has been made as thorough and impartial as possible within the time available, with a view to ob-

[1] For an abstract of the Summary Report of the Committee see Management Engineering for August, 1921, p. 71.

taining at first hand the real facts upon which to base constructive recommendations or suggestions for improvement. The percentage of waste in each of the 15 plants studied is shown in graphical form in Fig. 1, while Fig. 2 shows that this percentage has no relation to the size of the plants. Fig. 3 is based upon the various studies made and shows in estimated figures the extent of waste in the metal trades industry for the whole United States.

The results of the comparative studies made of the 15 plants are given in Table 1 in the nature of a Summary Evaluation Sheet. All the plants were graded or rated as to the percentage of "waste," using for that purpose a complete "questionnaire" developed by the committee. The three main divisions of this questionnaire are:

ORGANIZATION: Mechanism of industry as to type, methods (paper work) and personnel. Assignment and discharge of responsibility and relationship.

TECHNICAL: Available engineering knowledge as to product, plant, and materials.

UTILIZATION: Effectiveness of technical knowledge and organization. Direction, control, and accounting factors.

In these three main divisions there are 46 factors, each one of which was "weighted" according to its relative importance revealed by experience and close study in that type of plant investigated. The total points add up to 100. The grading of the "efficiency" of each plant as to each factor was done very much as students at school are graded in different subjects.

Some of these plants have "old-fashioned management," some have "modern management," and others are in between. This chart indicates the "high spots," or the strong and weak points in each plant. Many of the plants specialize on *quality* of product, but are not organized to control their cost nor to get the most production out of the plant under normal conditions. One plant disregards all accepted methods of purchasing or storekeeping, and the foremen order what they want and go to stores for anything they think they need.

The major causes of waste or non-production, applicable to normal times as well as to the present abnormal times, may be classified for convenience as follows:

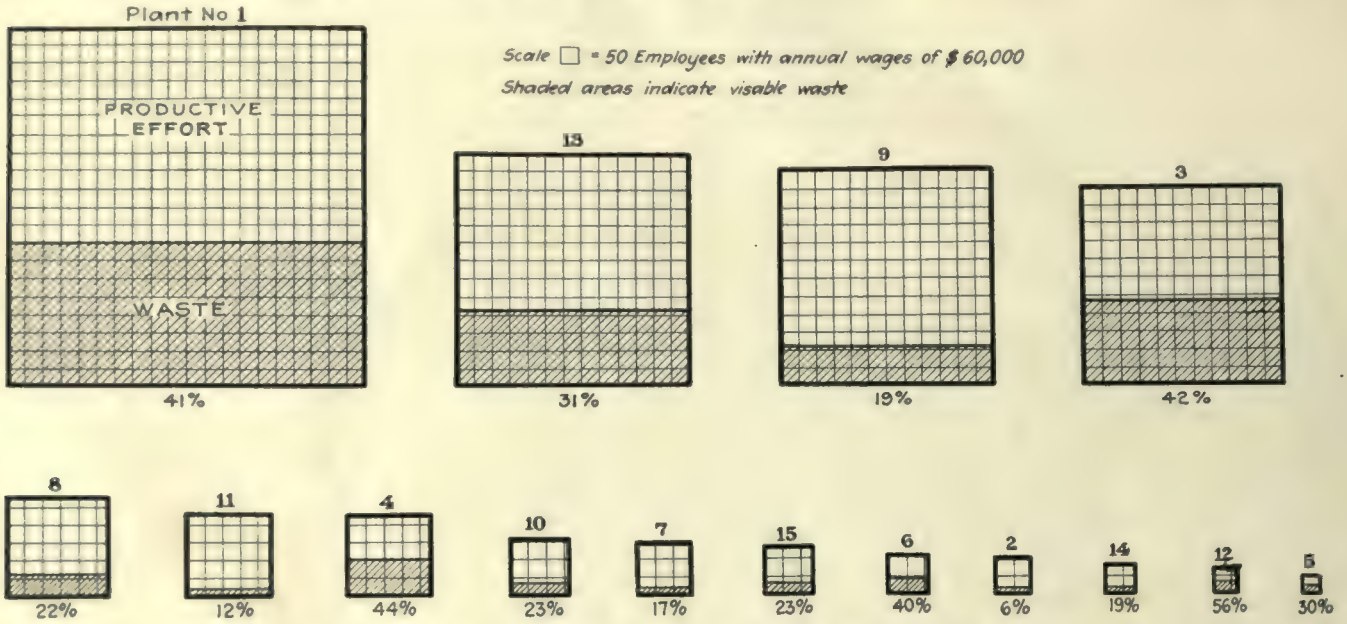


FIG. 1 WASTE IN 15 REPRESENTATIVE PLANTS OF THE METAL TRADES INDUSTRY

The percentage of waste in the above representative plants was arrived at by evaluating the various elements or factors in each plant, and using another plant as the standard (excellent or 100 per cent) each plant being graded accordingly, for each of the 46 waste factors given in Table 1. These factors were weighted or given their relative values or weights, based on comparisons and experience, totaling up 100 points.

1. Instability of labor employment, including both fluctuations in the number of employees in individual plants or shops, and the high labor turnover. Strikes and lockouts come under this heading.
2. Inefficient management, which includes:
   (*a*) Lack of foresight and planning; scheduling and routing materials effectively.
   (*b*) Lack of proper standards of performance, by which to gauge the ability of the workers.
   (*c*) Lack of standardization of equipment, tools, and product.
   (*d*) Inadequate transportation and material handling facilities.
   (*e*) Inadequate cost control methods.
   (*f*) Lack of proper incentive systems, based upon fair standards and confidence between employers and employed.
3. Labor organization rules or customs—such as restricting individual output or making it impossible for management to instal proper incentive systems—due either to lack of mutual confidence or a misunderstanding of the mutual benefits from increased production.

4. Waste of material for various reasons—such as lack of a well-organized inspection system; lack of careful training and instruction of workers; lack of care and interest in the work.
5. Lack of thorough research work or staff study—including the study of materials, processes, and methods, equipment, and production.

Most of the plants surveyed give very little thought to the instability of labor employment. When studies are made in a plant of the fluctuations in the number

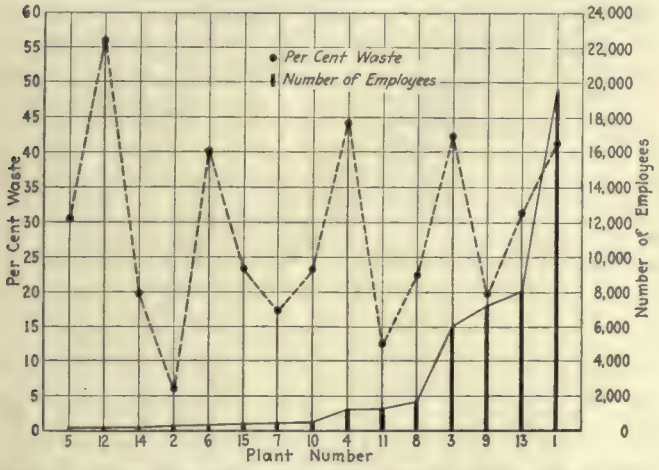


FIG. 2 CHART SHOWING THAT THE SIZE OF PLANT BEARS NO DEFINITE RELATION TO PER CENT WASTE

of employees, the management is usually surprised to find how unstable the working force really is. Three charts (Fig. 4) are shown for three plants taken at random, showing the wide range in the numbers employed during the past two or three years. These fluctuations were not due to seasonal employment but largely due to lack of planning ahead and scheduling for continuous employment on the contracts in hand.

INTERNAL RELATIONS

The proper relationship between management and labor, such as exists in the most productive plants investigated, is more than ever a controlling factor. The plants with the highest labor turnover (which reflects discontent) are in general the most wasteful of human effort, hence secure the smallest production per man-hour. It is further found that generally the best relationship exists and the best understanding and least friction prevail in plants where the most thorough and scientific study of organization methods and standards have been made by the management in co-operation with the workers. The careful planning of work, the providing and the moving of materials by means of effective and organized methods of material control; comparison of output of departments and of individuals with fair standards of performance, fairly and scientifically determined; these are the practices of those concerns which have been most free from labor unrest, and where greatest mutual confidence and co-operation exist between employer and employed.

The provision by the management of proper facilities and convenience for developing the latent productivity of the workers and the provision of fair incentives for those who "make good" play a large part in eliminating waste in the best establishments.

COST OF LABOR TURNOVER

In order to visualize the cost of the labor turnover in the metal trades industry, let us take some conservative figures and estimate the "waste" in production in the industry due to this source. The average labor turnover for the year 1920, for the plants covered by these studies (wherever records were kept, which was the case in less than half of the plants) was 160 per cent—the percentage given in most cases being the ratio between the number of "separations" and the average number on the pay-roll. The highest turnover was 366 per cent. An estimate by the Metal Manufacturers' Association of Philadelphia for the whole industry is that "it would average between 150 and 170 per cent, for 1920. In the earlier months of the year, when the demand for labor was very great and the supply inadequate, in some shops it ran as high as 300 per cent, on an annual basis. This turnover was computed as the ratio between the total separations and the total average daily working force."

There is a practical "minimum" to the labor turnover in a shop or factory which we cannot expect to excel except in special cases; there are "separations" that are unavoidable due to deaths, marriages, etc., for which 60 per cent may be allowed, which still leaves an avoidable or preventable turnover of, say, 100 per cent annually in the metal trades industry. This, of course, can be done only with a most thorough understanding

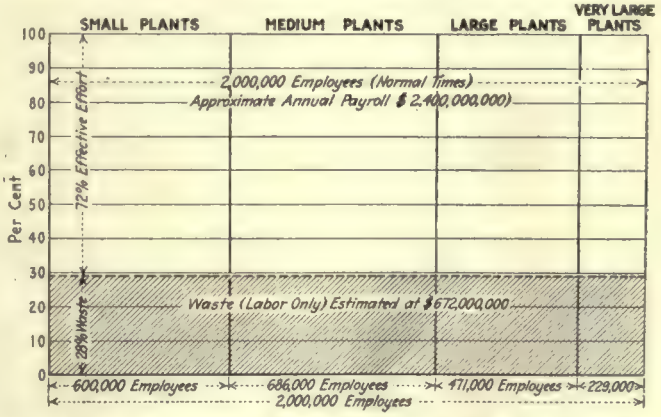


FIG. 3 CHART SHOWING ESTIMATED WASTE IN THE METAL TRADES INDUSTRY OF THE ENTIRE UNITED STATES

and co-operation of all concerned: management, labor, and the public.

In this industry then, with its two million employees, with the average plant virtually renewing its entire working force, or filling each position one-and-a-half times a year, we have two million unnecessary "separations," the equivalent of two million workers annually separated and rehired elsewhere, and at what cost? Expert estimates of the cost of labor turnover vary from $50 to $250 per employee hired, trained, and separated. An average figure of only $50 each applied to two million employees "turned over," means an

average "waste" of one hundred million dollars due to avoidable labor turnover, in this one industry.

Instability of labor employment resulting from strikes and lockouts has not been so serious in the metal trades industry as in some other industries with the exception of the shipbuilding branch of this industry. The demand for labor in this branch increased tremendously during the war—far exceeding the supply—and in the space of two years the number of employees engaged jumped from 100,000 to 400,000. Wages were greatly increased as a natural consequence, and questions of wages and piece rates have been a prolific source of dispute.

The following record of strikes obtained from the Atlantic Coast Shipbuilders Association gives an idea of the lost time and "waste" in nine shipyards between October 1, 1919 (when an agreement was signed between some of the shipyards and the labor representatives) and January 1, 1921—a 15 months' period: 40 strikes affecting 21 different trades; total number of men out 10,538; number of hours lost 546,079; earnings lost by the workmen $408,902.

In the machine tool business in Ohio, there was a general machinist strike in the summer of 1920, which affected a number of plants seriously. In the Philadelphia District, the metal trades have been fairly free from serious strikes (except in shipbuilding) and in the membership of the Metal Manufacturers' Association, in 1920 there were only three strikes, two in small foundries and one in a brass shop.

An open interchange of ideas and business results by managements both in the particular industry and in other industries, should lead to a higher level of methods, service, and general business ethics. If carried on through definite channels such interchange might easily result in a combined study of the possibilities of the future and the avoidance, in the years to come, of such conditions as we are now facing. It is evident that management of labor must be elevated to a higher plane. Because labor is the major factor in most if not all industries, it should be led by recognized intelligence rather than by radical agitators on the one hand or by stupid reactionaries on the other. Remarkable and very favorable results have been secured in labor relations and in improvement of efficiency simply by establishing frank and open conference and free interchange of opinions, usually in genuine open shops (shops in which no prejudice or discrimination is allowed to exist either for or against men who do or do not belong to labor organizations) and sometimes by collective bargaining and dealing with a shop committee to which is delegated all responsibility for keeping the men to agreements which

TABLE 1 SUMMARY EVALUATION SHEET

	Questions	Management Points	Labor Points	Outside Contacts Points
Organization				
K 1	Have you an organization chart or its equivalent?	.16	0	0
K 2	Is your organization functionalized or is it built around individual personalities?	.71	0	0
K 3	Are the duties of each executive in your organization written up?	.31	0	0
K 4	Are there standard written instructions for each executive or functionary?	.50	0	0
K 5	Have you a research department that is not devoted wholly or in part to current production problems?	.46	0	0
K 6	Do you keep up-to-date personnel records, particularly with reference to quantity and quality of production?	.37	.01	0
K 7	Are your workers selected carefully on basis of interviews, trade, and other tests?	1.04	.09	0
K 8	How much does employment fluctuate?	.15	.05	.25
K 9	Are records of discharges and layoffs tabulated by causes?	.37	.04	.03
K 10	Do you make a practice of shutting down for inventories, unbalanced production, business fluctuations, etc.?	.09	.06	0
K 11	Do you follow up and investigate quits?	.21	.07	0
K 12	Do you tabulate and analyze labor turnover by causes?	1.05	.69	.09
K 13	How is wage remuneration determined, union scale, competitive market, etc.; daywork, piecework, or other forms of incentive wage?	.31	.07	.26
K 14	What are the hours of labor per day and week and how and by whom determined?	.18	.06	.05
K 15	Is yours an open union, closed union, preferential union, or non-union shop?	0	.03	.04
K 16	What form of shop representation have you?	.01	.05	0
K 17	I uring the last five years what has been your strike record as to frequency, duration, causes, number affected, etc.?	.38	.35	.14
K 18	During the last five years what has been your stoppage record as to frequency, duration, causes, number affected, etc.?	.09	.08	.06
K 19	Are your industrial relations directed by a competent functional personnel head?	.33	.06	0
K 20	What does your accident record show as to the degree of danger of personal injury?	.24	.03	.09
K 21	To what extent do you carry on personnel service work?	.36	.02	.02
	Total	7.32	1.76	1.03
Technical				
T 1	What organized external co-operation do you participate in with your own similar and interrelated industries?	.62	0	.28
T 2	Have you an up-to-date staff-made plant lay-out showing location of departments, work places, path, or work, etc.?	.85	0	0
T 3	Do you maintain an up-to-date equipment inventory showing cost, repairs, depreciation by individual pieces or groups?	.30	0	0

were fairly made between management and employees.

Fig. 4, previously referred to, shows the increase in output per employee from 571 units a month in 1918 to 1,325 units a month in 1920, due to the plant's running nearer capacity and due to improved management. This is an example of increasing production per employee of over 132 per cent. If production of 1,325 is considered "standard" or excellent, the previous production of 571 was only 43 per cent efficient, or a "waste" of 57 per cent. Numerous other examples of this nature might be given. One of the plants studied had been specializing for many years in a product and the management had believed the operation of the plant to be very efficient. The plant was modern and up to date in appearance, had a good labor market, and a year ago they were very well satisfied that they were getting out the maximum production, which was 20,000 units a week with 1,175 employees, or 18.7 units per employee. The president of the company engaged an industrial engineer as an assistant to the general manager. His duties were purely staff duties, research work, and study of the operations of the plant. The general manager and the superintendents adopted some of this engineer's suggestions one after another: the planning of work was improved; the routing of work was simplified and a few machines re-located; there were some improvements made in processes; a better and more careful inspection system for work in process was established under a separate department; the piecework system was extended, etc. A year later, at the time the survey was made, the production had increased from 22,000 to 34,000 and the number of employees had been reduced from 1,175 to 800. The output per man weekly had increased from 18.7 units to 42.5 units, or an improvement of 121 per cent. No additional equipment had been added. This engineer believes that with the present force production can be increased 50 per cent more.

Most of the metal products are manufactured "on order"—the result of the "sell-and-make" policy—which is one of the causes for the "ups-and-downs" in business. Moreover, many of these orders are more or less special in their character, i.e., departures from what may be considered a standard product are dictated by the buyer. Whatever may be done in the way of standardization of products would enable manufacturers in many cases to feel justified in manufacturing for stock, and thus not only would production be more steadily maintained but goods would be produced at materially lower costs; costs would be lower because of the greatly reduced investment required in buildings and equipment and in raw and finished stock carried in inventories.

OF WASTE IN 16 METAL TRADE PLANTS

	Questions	Management Points	Labor Points	Outside Contacts Points
T 4	Are there written standard specifications for equipment for each of the various operations?	1.23	0	.10
T 5	Is your equipment maintained by a periodic repair inspection made by a separate maintenance department?	.26	.01	0
T 6	Are your tools standardized for each of the various operations?	.48	0	.09
T 7	What is the extent of variety in product design and construction?	.55	0	.49
	Total	4.29	.01	.96
Utilization				
U 1	Do you establish a progressive budget based on knowledge of your manufacturing capacity and forecasts of your business volume?	1.15	0	0
U 2	Is your manufacturing policy to make-and-sell or sell-then-make?	.11	0	.31
U 3	Do you compile a record of idle machine-time by amount, cost, and causes?	.63	0	0
U 4	Is your planning of work centralized or distributed among a number of shop executives and workers?	1.84	0	0
U 5	Does your shop administrative mechanism enable you to anticipate idleness of machines and workers and provide against it?	.76	0	0
U 6	Is there a work ticket for each work assignment or its equivalent provided in advance and on which elapsed time is recorded by mechanical time stamp?	.28	.11	0
U 7	Have you a good current cost system tied in with the financial books?	1.79	0	0
U 8	Do you compile a record of idle workers' time by amount, cost, and causes?	.52	.10	0
U 9	Do you compare production performance with production standards, with reference to worker, job, department, and equipment?	.64	.08	0
U 10	Has production per man-hour increased or decreased since 1914, and how much?	.30	.15	0
U 11	To what extent is purchasing done to standard specifications and does it clear through a purchasing agent?	.61	0	.35
U 12	What control exists over receipt, issuanee, and return of materials?	.89	.06	0
U 13	Is material storage convenient of access and arrangement and does it conserve space properly?	.77	.06	0
U 14	What types of internal transportation are used?	.51	.11	0
U 15	Is raw material subjected to careful examination and tests on receipts?	.19	0	.08
U 16	Is there competent independence functionalized inspection of work in process with rigorous quality discipline?	.41	.09	.09
U 17	Is there competent independent functionalized inspection of finished product?	.14	0	.04
U 18	What is the amount and character of inspection equipment?	.15	0	.02
	Total	11.69	.76	.89
	Grand Total	23.30	2.53	2.88

The great variety of designs called for by those who buy street cars, locomotives, trucks, and other transportation equipment, is well known to be capable of beneficial limitation if manufacturers and users could, through some agency, get together and by scientific study of the problems, not only from a utility or service standpoint, but from a manufacturing standpoint as well, reduce as much as possible the enormous number of varieties, styles, and types now required to be built. Many of these varieties are largely a matter of personal opinion or judgment of the buyers who have not had the opportunity to study the subject.

Taylor, Gantt, and others repeatedly declared that the greater part of the failures of industrial establishments to attain high efficiency is caused by failures in management. This has not been generally believed and it so happens that things pertaining to the workman and his contribution to industry have, until recently at least, received most attention in the technical and news press. As a matter of fact it is often somewhat difficult to decide with certainty whether failure to attain a reasonable degree of efficiency is due to shortcomings of the workers or to those of management.

When an establishment is low in efficiency it is usually true that the workers by taking greater interest in their work, or by simply working harder, can bring about some improvement. But, on the other hand, it is generally conceded that one of the problems of management is to stimulate and maintain the interest and co-operation of workers. When this has been done, as in many cases it has been either by a change in personnel of the management or by a change of attitude and practice without change of personnel, what had appeared to have been entirely the fault of the workers was seen to have been remediable by the management and therefore to have been the management's responsibility.

In all cases it was found that an adequate cost system was needed. In controlling production through the plant and in judging fairly and accurately when and where progress and improvement are being made, it was found that a modern cost system is a most effective means in some of the plants. The lack of a good cost control system in other plants (in fact the majority of plants lack such a system) is necessarily a source of much waste. This lack prevents accurate and prompt correction of defects because the defects remain hidden and unobserved.

It is found that the average metal working plant is 25 to 30 per cent behind the best plant in output per employee, which situation can be greatly improved by a proper understanding between management, labor, and the public.

The assay of this industry had for its object, to find

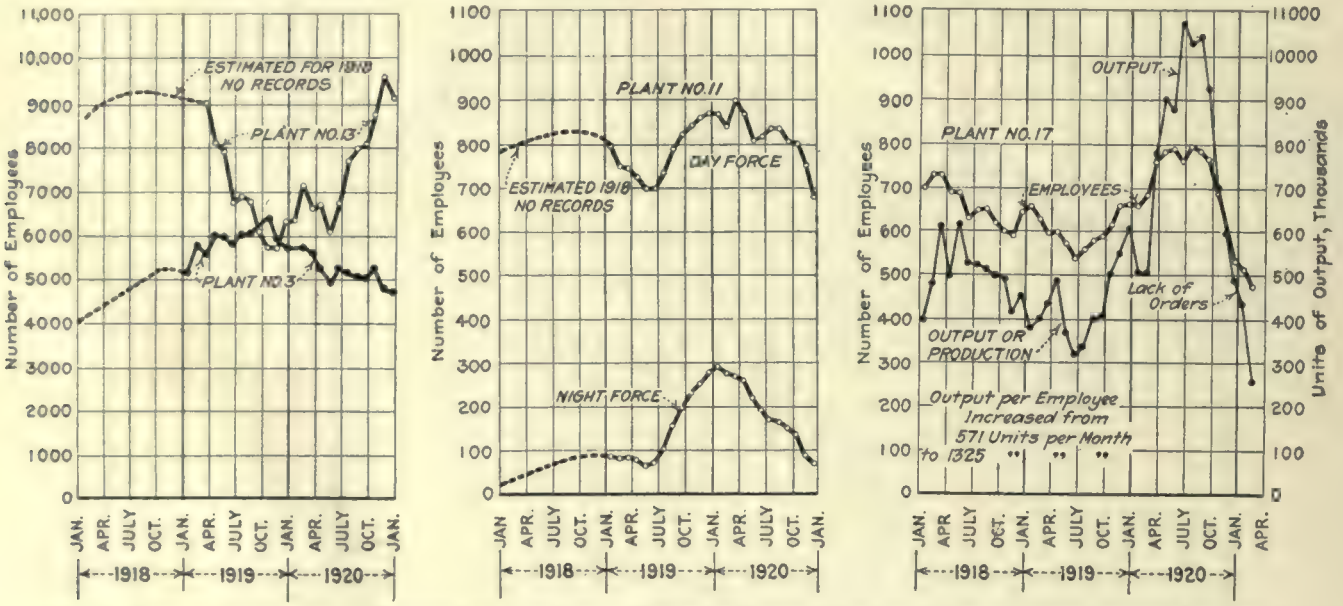


FIG. 4 CHARTS SHOWING THE FLUCTUATIONS IN LABOR FORCES IN TYPICAL PLANTS OF THE METAL TRADES INDUSTRY

out the following:

1. How nearly the methods in use in typical establishments attain the standards of the best plants in the industry.
2. So far as possible the reasons for failure to attain them.
3. To whom the responsibility for such failure belongs; and to evaluate that responsibility.
4. What may be done to bring about possible improvement.

It is the difficulty of attaining, or of even approximating the standards of the best plants in the industry without an adequate organization and the best of methods of administration that gives rise to the belief, quite commonly held, that an establishment can become so large as to be "unwieldy" and "unmanageable," whereas those who know the virtues of thorough organization and of proper distribution of authority and control, place no limitation upon the magnitude of a really well managed and efficient establishment. But the large establishment must disregard the "bugbear" of "non-productive labor" and must see to it that each executive, major or minor, must have only as much as he can attend to thoroughly.

The Final Measure of Industrial Efficiency

Whether Plant or Industry, the Most Efficient Produces the Greatest Amount of Product with the Least Outlay

By A. L. DeLEEUW

Consulting Engineer

THE recent movement for the elimination of waste in industry brings a question before the engineer which must be answered before an intelligent attempt can be made to accomplish the object sought. This question is: *What is waste?* The word is used so much in daily life that, like many other words similarly used, it has lost its definite meaning and must be redefined before it can be used in an analysis or controversy. For the purpose of this article the author will define waste as "that part of expended material or effort which *could have been,* but *was not,* utilized."

That we utilize only 25 per cent of the heat value of coal in a power plant does not mean that there is 75 per cent of waste, for it would not be possible to utilize all of the heat value of coal in such a plant. If, on the other hand, it is possible to construct a plant in which 25 per cent of the heat value of coal is utilized and we find that we obtain only 20, then 5 per cent out of the 25 per cent is wasted and our efficiency is but 20/25, or 80 per cent.

How Much Can Be Utilized?

The definition of waste has brought the question but slightly forward because we are now confronted with a new question, namely: How much *can* be used? Though it is possible to construct a power plant in which 25 per cent of the heat value of the coal is usefully employed, yet there are many cases in which it would not be advisable or economical to make an attempt to use this full percentage. A steam-driven hoisting plant in the field, or a pile driver or a donkey engine, may have an efficiency, as viewed from the standpoint of coal consumption, of only 1 per cent of that of an ideal stationary power plant, and yet may be quite efficient if all other factors are taken into consideration.

As waste is a negative quantity it is perhaps better to speak of its complement, the positive quantity which *is* being used; and still better, to compare this positive quantity with the total amount which should be used, and call this quotient "the efficiency of the industry."

If we have a process in which an amount of material is used which we shall call 100, and if the nature of the process does not permit us to utilize more than 75, then the maximum possible *efficiency of this process* is 75/100. If we find that in this industry only 60 out of every 100 is usefully employed, then the total efficiency is 60/100, and the efficiency of the industry is 60/75. Using the symbol E_i for the efficiency of the industry or plant under consideration, E_p for the efficiency of the process (in other words, the greatest possible efficiency) and E_t for the total efficiency, we have $E_i = \frac{E_t}{E_p}$, and the waste equals $1 - \frac{E_t}{E_p}$.

In the above example $E_p = 75$ per cent, $E_t = 60$ per cent, and therefore $E_i = 60/75 = 80$ per cent, and waste $= 1 - 0.80 = 20$ per cent. If we had merely looked at the fact that only 60 out of 100 is usefully employed, we would have come to the conclusion that the efficiency of the process is 60 per cent, which would have been wrong.

The first step, then, to determine the efficiency of an industry, a plant, or a process, is to find the maximum obtainable efficiency. This is not easy to do, except in a very few, simple cases. Almost any industry uses a number of materials and processes, and almost any organization is composed of various organizations more or less parallel and co-operating with each other with one aim in view. It is very well possible that each of these individual organizations may act very efficiently and yet their method of co-operation may be faulty, so that the total result may be unsatisfactory. In order, then, to determine how efficient a complex organization is, it is necessary first to establish the desired manner of co-operation between the constituent organizations. And before this can be done, it is necessary to establish a common aim for all these organizations.

The Combination of Losses

If we follow the losses which occur when a material goes through a number of processes before it reaches its final completion we can, as a rule, combine these losses and predict the percentage of material which will be left in the completed product. Such a method might be followed in the milling of flour, in the reduction of ores, in the conversion of iron into steel, and in many other processes of similar nature. If, in the first step of a process, there is an unavoidable or irreducible loss of 5 per cent, in the second step a loss of 3 per cent, and in the third of 8 per cent, we know that we shall have left at the end of the three processes $0.95 \times 0.97 \times 0.92 = 0.8478$; so that the total efficiency up to this point is about 85 per cent. Such a simple method of combining efficiencies cannot be followed when we analyze organizations; for, as was pointed out before, organizations do not, as a rule, work in series but in parallel.

The only starting-point we have for a system of combining the efficiencies of various suborganizations is

the fact that they must all have one aim. As a rule, this aim is the making of profit. There are apparent exceptions such as we find in cases of emergency—in war, for instance; but the difference is more apparent than real. The way to make profit is to produce with the greatest possible economy, so that the means of making profit is merely a system of economical production. In emergency cases, also, there is a desire to produce with the greatest possible economy; with this difference, however, that whereas a factory produces shells in peace time at the lowest possible cost, in war time cost is only one of the elements which must be kept in view. The ultimate aim of making the shells is no longer the making of profit, but we still have in mind ultimate economy; that is, the finishing of the war with the lowest possible expenditure of lives and treasure, and if this can be accomplished by hastening the manufacture of ammunition at perhaps a greater cost per unit, then the ultimate economy has been obtained.

COMMON AIM IS ECONOMY AS A WHOLE

We may say, then, that the common aim of all sub-organizations is economy of the plant or industry as a whole. To illustrate this, let us consider the relations between the sales and the production departments. The highest efficiency of the production department is reached, as a rule at least, when the plant is fully utilized to the limit of its capacity; but unless the sales department succeeds in obtaining orders, it would be folly to produce at this rate. In other words, the highest possible economy cannot be reached by the production department alone. Similarly, if the sales department could obtain orders much beyond the capacity of the plant, its efficiency might be high—that is, the selling expense per dollar's worth of orders might be low—and yet a great deal of money might be wasted because orders have been taken which cannot be executed by the plant. A certain kind of co-operation, therefore, is required between these two departments in order to bring the total economy to a maximum.

In the diagram of Fig. 1 some relations between sales and production departments are represented. The curved lines to the left of the line XY represent the expenditures, while the efficiency is expressed by the curve to the right of XY. The left-hand curve is built up out of three items which are shown in the diagram: the overhead, the direct labor, and the direct material costs. The horizontal scale shows what percentage of the possible output is made by the plant, while the vertical scale represents units of expenditure. The three elements out of which the costs are built up are chosen quite arbitrarily; it will be seen that the overhead remains almost constant with but a slight rise when production goes up, and that the direct labor and material costs are shown here in direct proportion to production. None of these three assumptions is entirely correct in practice, but they are all near enough for the present purpose.

The manner in which the diagram to the right of XY is constructed is as follows:

The total length of the line AC represents the total costs at 100 per cent production. It also represents the value of this 100 per cent production, and it indicates, too, the fact that the efficiency is 100 per cent. If now we choose a point halfway on the line AC, and let this represent the point of 50 per cent production, then the question is, what is the efficiency at this point? The point D indicates the cost at 50 per cent production, because it is situated directly above point 50 of the horizontal scale; so that the percentage of efficiency can be expressed by $\frac{AB}{DE}$. And if we consider the line AC as representing 100 per cent efficiency, then we must find a vertical line of which the length equals $\frac{AB}{DE} \times AC$. The length of this line equals the line FG. In a similar manner we find other points of the efficiency curve which is drawn to the right of the line AC.

It was mentioned that this line AC represents the value of the output. This was not meant to be the sales value, but the value at the plant. The line AH, however, expresses the sales value of the same product. In this particular case. 50 per cent was added to the plant value for profit and selling expenses. Joining the point

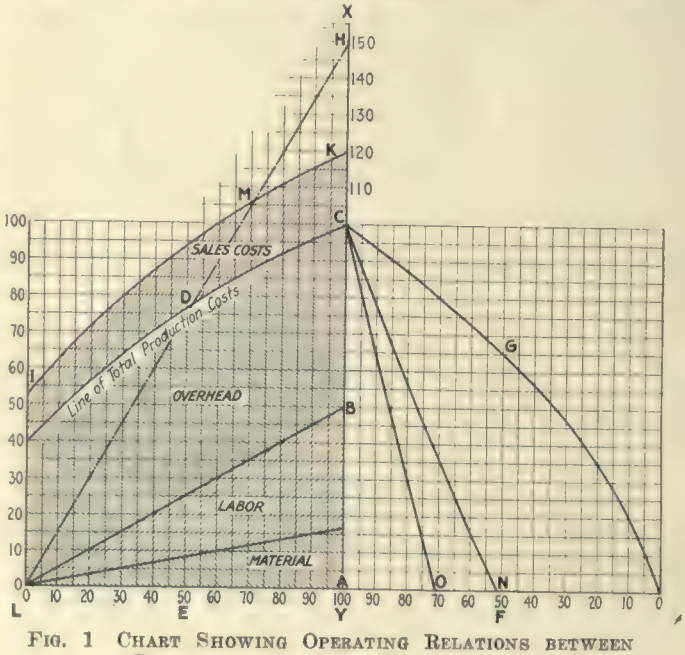


FIG. 1 CHART SHOWING OPERATING RELATIONS BETWEEN PRODUCTION AND SALES DEPARTMENTS

H to the point L by a straight line, this line HL becomes the diagram or curve for the sales value at various percentages of output. For instance, at 50 per cent output, the sales value will be found by the intersection of this line with the line DE. It will be seen that this line HL intersects the diagram of costs. At this point of intersection there is no profit. At all points below this intersection there is loss; at all points above, gain.

Transferring the upper part of the diagram of profit to the right of the line XY, we obtain the line CN as the diagram of commercial efficiency, provided we leave selling costs out of consideration.

If we assume that the line IK represents the diagram of selling costs, so that the amount of selling costs may

be found by measuring the vertical lines anywhere between the lines *IK* and the line of total production costs, we find that there is neither profit nor loss at the point *M*. All points above the line *MK* represent profit and all points below represent loss. Again transferring the diagram *HMK* to the right of the line *XY* we obtain the line *CO* as the diagram of commercial efficiency, this time having taken selling costs into the consideration. We see, therefore, that the line *CG*, which is the efficiency line for manufacture only, is entirely different from the line *CN*, which is the efficiency line if we consider profits caused by the manufacture, whereas *CO* is the efficiency line caused by the combined efforts of production and sales departments. This shows that the diagram of efficiency of one department is affected by that of another department.

Though the sales department may have been 100 per cent efficient, the mere fact that there is such a department has modified conditions. The reason is this: the aim of the production department is production; the aim of the sales department is sales; but that of the two combined is profit. This change of viewpoint or aim changes entirely the considerations which lead to the determination of efficiency.

Impractical to Ascertain a Combined Efficiency

Supposing we had found a formula by which we could combine the efficiencies of the sales department and the production department so as to get the efficiency of the entire plant, we would still have nothing but the efficiency of this particular plant under the conditions under which it works. But it would not give us the efficiency as compared to the possible efficiency of a plant arranged for this particular product. The plant might have been unbalanced. The unbalanced condition might have existed between the various departments or it might have been an unbalanced condition in one or more of the departments. Taking as example again the production and sales departments, it may well be that the capacity of the sales department is in excess of the capacity of the production department. Working at full efficiency the sales department might be able to obtain orders for two million dollars' worth of product, whereas the production department cannot turn out one million dollars' worth. Again, it might have been the reverse. Then, again, supposing that these two departments are properly balanced, it may well be that one part of the plant is developed excessively as compared to other parts, so that a portion of the capital must necessarily lie idle. It follows then that, before we can discuss the efficiency of a plant, we must be sure that it is properly balanced.

It may well be that two plants are engaged in the making of the same product, but that the processes of manufacture are different. Each of the two plants may be 100 per cent efficient under its own peculiar conditions and yet one of the two plants may be more efficient than the other, and this would be due to the fact that a different process is employed. In order, then, to find out what is the highest attainable efficiency in the manufacture of any product, we would have to examine all the various processes used, select the best process at every step and combine these to one ideal system of manufacture. This system would be our standard by which to judge the efficiency of existing plants. The amount of investigation required to establish such an ideal standard for even one single industry would be enormous and could probably never be carried out. It is therefore necessary to look at the entire proposition from a different standpoint.

It Is Practical to Compare Production and Outlay

Without going into the details which have caused the final result, we are bound to agree that that plant is the most efficient which produces the greatest amount of product with the least amount of outlay. Whether the better results are due to a more favorable location, or lower freight rates, or a better system of management, or better processes of manufacture, or what not, the fact remains that the plant which produces one dollar's worth of output with the least amount of outlay has the highest efficiency. There is only one point which might be debatable and that is the wage rate paid by this particular plant. If, because of peculiar conditions, it is possible to pay lower wages for the time being than those paid by other similar plants, it may be argued that this can be of a temporary nature only and is not even desirable as such; this matter will be taken up somewhat later on. With the exception of the uncertainty of this one point, the acceptance of the statement that the highest efficiency depends on the greatest output and smallest outlay will lead at once to a method by which we can determine the highest existing efficiency of plants engaged in the same industry. All we have to do is to ascertain the two factors, namely, output and outlay.

Not Difficult to Ascertain Amount of Output

The difficulties in ascertaining the amount of output are, as a rule, not very great. The value of output may differ on account of changing prices, but in general prices change uniformly throughout an entire industry; so that the relative efficiencies of plants would not be affected by the actual selling value of the product. For our purpose we may even give a fictitious value to a unit of output. If, for instance, we should give the value of one dollar to a pound of output in a certain industry, and if there is a plant which produces this product with $85 of outlay for 100 lb. of product, then if some other plant would produce only 95 lb. of product with $85 worth of outlay, the efficiency of the second plant as compared to the first one would be 95 per cent, and that regardless of what the actual price per pound might be at a given moment. It is not so easy, however, to determine what is the outlay of a given plant.

The expenses chargeable to manufacture are: wages and salaries, cost of materials, and capital charges. It might seem that provision should be made for cost of repairs and depreciation, but such charges are true capital charges for the purpose we are considering

now. It is not difficult to determine the actual amounts spent for salaries, wages, and materials, but when it comes to capital charges there is much room left for discussion. The writer takes the following view of what constitutes capital charges for the purpose of determining the true outlay in the manufacture of a given product.

CONSIDERATION OF EQUIPMENT EFFICIENCY

The plant will be considered as having been purchased with borrowed money. It must be maintained to its full productive capacity at all times. The necessary funds must be laid aside to make up for the difference between the actual present-day value of the plant and its present-day replacement value. If, for instance, a machine had been bought 10 years ago for $500 and a similar machine bought at the present time would cost $1,000, then the machine in the plant will be considered as a $1,000 machine. If its real present-day value as a second-hand machine is $400, sufficient funds should have been laid aside to make up for the difference between $1,000 and $400. However, regardless of whether this has been done or not, the productive value of the machine at the present day is that of a $1,000 machine, and whether we have a new machine of $1,000 standing in the plant or a $400 machine standing on the floor and $600 in cash in the replacement fund, makes no difference to capital. In either case capital has to furnish $1,000, that is, the present market value of a new machine. Of course, this is entirely different from the valuation of a machine for the purpose of taxation or insurance. In many plants a fixed percentage of the original purchase price is charged off every year, and in the course of a number of years the machine no longer appears on the books. In other plants a fixed percentage of last year's value is charged off, and the machine appears on the books with an ever-decreasing, but never disapproving, value. Still other systems are followed in other plants and there are arguments in favor of all of these systems. However, for our purpose none of these systems will do. We are dealing with the productive value of the plant, and as long as a certain machine can do the work for which it is intended it has its full value. The amortization fund may or may not exist; it does not affect the value of the machine as a productive factor.

If a machine breaks down its productive capacity stops and the value of the machine is temporarily zero. If it cannot be repaired its value remains zero or, at the most, its scrap value. If it is possible to repair it, its value will again be the original amount as soon as it is once more in working order.

CONSIDERATION OF PLANT EFFICIENCY

The same reasoning applies to a complete plant. Some plant might have been built at an expense of, say, one million dollars; it has run for a number of years, and is now offered for sale at half a million. The purchaser of this plant in figuring the cost of his product must take into consideration that he has bought only half the plant, and that the other half must be kept in reserve in the form of replacement fund to be expended at various times, partly for repairs, partly for renewal. In other words, the new purchaser must be in possession of one million dollars in order to purchase the plant for half a million and be assured that he can run the plant as it was intended to be run. If the replacement fund were not at hand at the time of purchase, loans would have to be made from time to time to furnish this fund when necessary.

It follows, then, that we must figure as the value of our plant the present-day replacement value, at least for the purpose of determining the efficiency.

INDUSTRIAL PROCESSES WITH REFERENCE TO EFFICIENCY

It might seem as if one item in the cost of a product had been forgotten. Industrial processes are apt to develop in the course of time into something better adapted to the purpose, more economical, in other words. Such a course of development may bring a process finally to a point where plants arranged for the older process can no longer compete. In order to provide for this possibility a sinking fund should be established so that capital will be left intact when the plant has become obsolete. In other words, another capital charge must be made against the product. It is, of course, impossible to say beforehand how long a process may be efficient enough to compete with later processes, but we are well aware that no human activity can be carried out without some risk. If we should arrange our sinking fund so as to take care of this contingency after 20 years and we find that we can keep on with our old process for 30 years, there will simply be an item on the positive side of our profit and loss account; and if, on the other hand, we have to make the plant obsolete after 15 years, there would be an item on the negative side. This much is certain: that if we do provide for this sinking fund—or, if one wishes to call it so, contingency fund—then this fund does not only take care of the final obsolescence but also of the partial obsolescence during the period that the plant is used.

THE INFLUENCE OF CAPITAL CHARGES

Another item which might be brought forward against this manner of looking at the problem is this: If we suppose two plants side by side, the one provided with all of the most modern improvements, the most productive machinery, and the best handling devices, whereas the other is arranged as was the practice 20 years ago, and if we should assume that the industrial efficiency of the first plant is not higher than that of the second one, because its capital charges are so high as to counterbalance the excessive labor cost of the second plant—the question might naturally be asked whether it is fair to say that their efficiencies are the same. If all industries should neglect to improve their plants, would not there be such an enormous demand for labor that the rate of labor would rise rapidly as a result of which the second plant would become much

less efficient than the first? In other words, doesn't the second plant make a good showing because its method is not followed?

If we look a little closer into this matter we will see that this is not so, provided that the capital charges have been properly figured out. We must not forget that the modern machinery, buildings, material-handling devices of the first plant are nothing but so many man-hours, produced in the past and loaned to the plant at an interest. If this interest equals the wages of 500 men and the number of men employed in the plant is also 500, then the second plant, the one with the old-fashioned equipment, is entitled to 1,000 men. It must never be forgotten that all material, equipment, etc., can be translated into man-hours. Instead of speaking of the cost of a product in dollars we might have spoken of it expressed in man-hours. However, doing this would not call the attention of the reader so clearly to the different items which are actually used in industry. We are in the habit of considering the dollar, or in general the unit of money, as translatable directly into material or equipment or labor, while we are not in the habit of translating man-hours into the same items. Besides, a man-hour is an indefinite quantity, depending on the nature of the work the man does, on his skill, and his zeal. The dollar also is a fluctuating unit, but it has the advantage that at any one time all dollars have the same value. And finally, though we speak of man-hour in the sense of what one man can do in one hour, we forget that the man works with tools, so that his output must be partly credited to the man and partly (and often by far the greater part) to the tool. For these reasons it was preferred to measure the efficiency of a plant on a money basis.

The various percentages which should be allowed for interest, depreciation, obsolescence, etc., cannot be indicated here. They must be determined by the engineer after thorough study of each individual case. The percentage of depreciation for a toolroom lathe is not the same as for a motor truck.

Relative Efficiencies and Index Numbers

Knowing outlay and output of a number of similar plants, it becomes possible to find their relative efficiencies. If, for a certain plant, the outlay is \$800,000 and the output \$1,000,000, then we will give this plant an index number $\frac{1{,}000{,}000}{800{,}000} = 1.25$.

Supposing that this index 1.25 is the highest index number obtained among all plants of the same nature and that some other plants of this kind have an index number of 1.10, 1.05, 1.00, then the efficiencies of these last plants would be $\frac{1.10}{1.25} = 88$ per cent, $\frac{1.05}{1.25} = 84$ per cent, and $\frac{1.00}{1.25} = 80$ per cent.

If later some plant should be found with an index of 1.30 or, in general, a higher index than the highest so far obtained, then all efficiencies must be multipled by the fraction $\frac{\text{former highest index}}{\text{present highest index}}$ which is, in this case, $\frac{1.25}{1.30}$

A classification of this kind, to be of any use at all, must be directly applicable to specific cases. Otherwise, it would merely provide pleasant pastime for those inclined to play with statistics.

An Application of Index Numbers

A low index number indicates waste, but does not indicate causes or remedy. In order to analyze conditions there should be given the percentage of the three main elements of expenditure: salaries and wages, materials, and capital charges. If, for instance, there should be two plants of similar nature, one of which has an index number of 1.25 and the other of 1.10, we know at once that the second plant is run wastefully, but we have no means of knowing where the fault lies. If now we know that the first one spends the money thus:

Salaries and wages	35 per cent
Materials	25 " "
Capital charges	40 " "

and the second one thus:

Salaries and wages	45 per cent
Materials	28 " "
Capital charges	27 " "

we see at once the following:

The fact that the one spends 25 per cent and the other 28 per cent of its money for materials shows conclusively that material is wastefully handled in the second plant. This should be corrected at once. Such a correction will have the following result:

Every dollar will be reduced to 97 cents, so that the index number will become $\frac{1.10}{.97} = 1.116$. This is still far below 1.25 and the percentages show that the difference is due to a discrepancy between capital charges and cost of salaries and wages.

There are now two possibilities left open. It may be either that salaries and wages are too high for the results produced, or it may be that the plant is underdeveloped; in other words, that the equipment is not of so high an order as it should be. There is, of course, also a third possibility—that both these faults exist. If the entire fault should lie with the first item, and if we should be able to reduce salaries and wages until we get the same proportion between this charge and the capital charge as we had in the first plant, then the charges for salaries and wages would have to be reduced to $\frac{35}{40} \times 27 = 23.625$, and we would have reduced the total expenses by the difference between 45 and 23.625. This, in addition to the saving made on materials, would bring the total expenses down to 75.625. Under those conditions the index number would become $\frac{1.10}{75.625} = 1.322$.

It is not likely that this could actually be accomplished, because the index number is higher than the highest one thus far obtained, but it opens up a promising field for investigation. The mere fact that the index number has become so high is at once an indication that the trouble lies partly with labor costs and partly with unsuitable plant.

Such an analysis would be of special interest where one company operates two or more plants for the same product. It must not be thought, however, that a difference in percentages of the three main items necessarily indicates that the one plant operates under more favorable conditions than the other. This is only true when the index numbers are different. For instance, should there be two plants, each with an index number of 1.25 and one with percentages like this:

Salaries and wages	35 per cent
Materials	25 " "
Capital charges	40 " "

and the other like this:

Salaries and wages	32 per cent
Materials	28 " "
Capital charges	40 " "

then this might simply indicate that, due to location, or for some other reason, the one plant has to pay more for its materials than the other (higher freight rates, due to greater distance from the source of supply, might account for this) but that, on the other hand, labor can be obtained either at lower rates or of a higher order.

EFFICIENCY OF AN INDUSTRY

So far we have been dealing with the efficiency of a plant; but the same would hold good for the efficiency of an industry. However, there is another source of wastefulness in industry, entirely apart from the efficiency of the plant, namely, the wastefulness caused by an unnecessary variety of products—sizes, models, styles, colors—and by unnecessary competition, which causes lots of product going through the plant, to be below its capacity. It is common practice, when two or more plants are consolidated under one management, to assign to each of them a few of the different products heretofore manufactured by each of them. Though it may not be possible to avoid such conditions entirely, yet the possibility of making a quick analysis would probably greatly assist in cutting out some of the unnecessary duplication which exists at the present time.

The scope of this article does not permit of going into this matter in detail. The remarks made so far are merely a rough outline of a system by which the efficiency of plants, processes, or industries may be measured and analyzed. Whether it will be possible to collect the necessary information from the various industries depends entirely on the degree of co-operation which these industries would give to such a general plan. In any case, there will be a certain limited use for this method of analyzing efficiency even at the present time, and if such a system would show its value by results obtained, there is no doubt but that self-interest would gradually extend its field.

Wages. Management *658.38*

An Analytic Method for Determining Wage Rates

By EDWARD PETERSEN

With the Walworth Manufacturing Company

IN recent years much attention has been given to the scientific rating of piecework jobs, but very little has been done toward working out a practical method whereby a fair and uniform day-work rate or piecework earning rate would be obtained and one on which the time-study men could base the piece-work rate. In the majority of cases the foreman fixes the wage scale for his department, and there are as many scales in a plant as there are foremen. It has, moreover, often been found that the same kind of work will pay more in one department than in another.

For example, in one of the plants that was studied, the malleable pouring gang's hourly rate was 78 cents, and the piecework earning rate was 97 cents. In the grey iron foundry the pouring gang's hourly rate was 73 cents and the piecework earning rate 87 cents, while in the brass foundry, pourers received 63 cents per hour and 78 cents on piecework. Of these three gangs the brass pourers had to carry the metal the greatest distance, and they also worked in the most unhealthful atmosphere. In another department machine operators were earning less than laborers in other parts of the plant.

THE DETERMINATION OF DAY-WORK RATES

Such conditions were found to exist in other plants under consideration, among them being cotton mills, chemical works, railroad shops, and rubber goods manufacturing plants. The need for a better method of adjusting wages was thus common to all of these; and while in the smaller plants the wages were fairly uniform as they were more directly under the supervision of the management, conditions in the larger ones were the reverse, thereby causing considerable jealousy and discontent among the workmen.

In order to arrive at a formula for day-work rates it was necessary first to divide labor or work into its various elements, such as skill, strength, speed, and working condition; and second, to analyze and separate thousands of existing rates for labor of various kinds in numerous plants into their elements and grades of elements in order to show the difference in rates paid the various grades. For convenience it was determined to base our deductions on the rate paid for the lowest type of labor and call it the basic rate.

Standardized definitions of the grades with examples of each were accordingly first determined, and these are given in Table 1. The element of skill was uni-

versally paid for by grade and the amounts paid over the basic rate were fairly uniform for all kinds of occupations. The allowances were slight for ordinary and average grades, but were increased rapidly when above average. Strength was generally paid for in direct proportion to the amount required for all classes, although on occupations requiring very little mental effort many cases were found where the rates were considerably less than would be indicated by the table. Speed allowances were found more clearly in individual instances and only slightly as classes. Work which was disagreeable or hazardous generally paid well where there was any scarcity of labor; the allowances were especially uniform when the work required a high degree of mentality.

Machine charge allowances were only found in plants that were thoroughly modernized and had definite machine-hour charges, and where the value of paying for exceptional men to get the highest possible production of a machine was known. In localities where men of any class were hard to obtain, it was, of course, necessary to make special allowances for this condition, as shown in the table.

The results of these studies were reduced to percentages, and for the convenience of the rating engineer were arranged in tabular form as shown by Table 2. These allowances of Table 2 were used in figuring standard hourly rates for a factory of 3,000 men engaged in a great variety of occupations, and they were found to be entirely satisfactory both to the men and the management.

A hypothetical case may be presented to illustrate the method involved. Let us take the pourer's rates before mentioned. This work requires men of ordinary skill (Class 2), high strength (Class 5) and since the working conditions are more disagreeable than the aver-

TABLE 1. STANDARD GRADES FOR DETERMINING BASIC WAGE RATES

CLASS AND GRADE OF WORKER	A—SKILL	B—STRENGTH	C—SPEED	D—WORKING CONDITIONS
1. Low.	Work requiring no exercise of mind. Sweepers, wheelers.	Very light work. Sweepers, clerks and timekeepers, inspectors on light material, core setters, core packers.	No Allowance	No Allowance
2. Ordinary.	Work requiring small amount of thought. Truckers placing material at particular points, grinders, machinist helpers, oilers, cotton waste machine tenders.	Small quantities of medium weight material. Handling very light product.	No Allowance	No Allowance
3. Average.	Work requiring some thought and care, and instruction. Operators on simple turret lathes on quantity production, operators on simple drill-presses, chippers, cotton duck weavers, wick weavers, rope machine tenders, sand blasters.	Assembling or testing light material. Machining large quantities of light material. Painters, plasterers.	No Allowance	No Allowance
4. Above Average	Work requiring a careful man, some mental concentration. Simple drill press on T lathe work requiring special care, simple work in small quantities, milling machine hands, galvanizing, loom fixers.	Handling material weighing 50 to 70 lb. (lifting) irregularly. Heavy trucking and wheeling. Moulding, foundry sand mixers, masons. Assembling or testing medium to heavy product.	No Allowance	Disagreeable conditions, i. e., hot, like pouring or loading mills with hot castings, work on wet floors, cleaning moulding floors.
5. High.	Great care, occasional mental concentration, close application, long experience or dependability. Floor-moulders, tool repair men, tool-room men, spinning and carding, machine fixers, testers and assemblers.	Lifting 2500 to 4000 lb. per hr. short distances. Bodily exertion producing fatigue. Assembling or testing very heavy material. Pouring.	Work requiring constant high speed and quick movements. Small plug threaders. Small nipple machines. Multiple spindle drill-press and tappers (single hole).	Disagreeable conditions, hot, dangerous, odorous, such as galvanizing, pouring brass.
6. Very High.	Work requiring mental concentration, close application, and long study and experience. Tool-makers and high-skilled machinists, pattern-makers, cabinet makers, electricians—first grade, high-grade moulders.	Lifting 4000 lb. of material or over per hr. Severe bodily exertion.	Work requiring exceptionally high speed.	No Allowance

age, and the foundry is constantly filled with the fumes of brass, percentages of Classes 4 and 5 must also be added. Referring to the table, we thus obtain a total of 26 per cent to be added to the basic rate for iron pourers and 36 per cent for brass, which with a basic rate of 50 cents would give us 63 and 68 cents, respectively.

THE DETERMINATION OF PIECE-WORK RATES

Investigations were also made of the average earning rates of workers operating under the various piece-work or bonus systems and these were found to be even more irregular than the day rates. A study of this problem was therefore made and, while the earning rates in existence in the various plants were of considerable assistance in this part of the work, it was found necessary to make further research by analyzing the effect on production of piece rates set for both low earning rates and higher ones. Experiments were, accordingly, carried on by means of careful time studies to determine this particular feature as accurately as possible.

TABLE 2. PERCENTAGES TO BE ADDED TO BASIC RATE TO OBTAIN DAY-WORK RATE

CLASS AND GRADE OF WORKERS	SKILL	STRENGTH	SPEED	WORKING CONDITIONS DISAGREEABLE OR HAZARDOUS	MACHINE CHARGE	MEN HARD TO OBTAIN
1. Low	....	.....	....	.....	.....	.....
2. Ordinary	4	4	....	.....	.....	.....
3. Average	6	6	....	.....	.....	.....
4. Above Average	10	8	4	10	4 over $1.50	10
5. High	20	12	6	20	6 " 2.50	15
6. Very High	30	16	8	30	8 " 3.50	20
7. Exceptional	40	20	10	40	10 " 5.00	30

It was found that in order to keep a worker contented and in a state of mind to use his greatest effort, it was necessary to set piece rates so that the earning rates of workers with even a minimum of mental capacity would equal a certain percent over their day-work rate, and that the inducement must be greater as the grade of skill advanced. Furthermore, although the results showed that skill was the principal element governing the percentage necessary to add, it was found that work that required the higher grades of strength, speed, etc., required special inducements to get the highest effort of the worker.

Table 3 shows the percentages arrived at as a result of this study, and to illustrate the use of the table we will again take the case of the pourers. It was found by applying the day-work rate allowances that the iron pourers should have received 63 cents. These workers, as shown above, were in Class 2 of skill (for which we find an allowance of 20 per cent) Class 5 of strength (for which we find an allowance of 8 per cent) and Class 4 of working condition (for which no allowance is made). The total of these allowances, or 28 per cent, is then added to the day-work rate of 63 cents in order to obtain the piece-work earning rate of 81 cents. In the same way, using the classes as shown for brass pourers, we get a total of 33 cents to be added to 68 or 90 cents.

Another example may serve to illustrate the use of the machine charge allowance. A worker operating a large boring mill is assigned to work requiring Class 5 skill, Class 5 strength, Class 3 speed, and Class 3 working conditions. Referring to Table 2 we find an allowance of 20 per cent must be made for skill, 12 per cent for strength, and zero per cent for both speed and working condition. This would give us a total of 32 per cent, which when added to the basic rate of 50 cents would give us 66 cents. Normally this would be the average operator's rate. But the machine we are considering has a high machine charge for it is costing the company over $3.50 per hr. for repairs, small tools, power, light, and heat, floor space, etc., and it is obviously worth while to pay a higher rate to get the highest possible production. Referring again, therefore, to Table 2, we find under the column "Machine Charge" that an additional allowance of 8 per cent should be made for operations of machines having a charge of $3.50. The resultant rate would then be 70 cents instead of 66.

The allowance for piece-work earning rate as shown in Table 3 would also be increased and would be made up of Class 5 skill (30 per cent) Class 5 strength (8 per cent) Class 3 speed (zero per cent) Class 3 working conditions (zero per cent) and $3.50 machine charges (8 per cent), or a total of 46 per cent which, added to the day-work rate of 70 cents, would show that the operator should earn $1.02 per hr. while on piece-work.

TABLE 3. PERCENTAGES TO BE ADDED TO THE BASIC RATE TO OBTAIN PIECE-WORK EARNING RATE

CLASS AND GRADE OF WORKERS	SKILL	STRENGTH	SPEED	WORKING CONDITIONS DISAGREEABLE OR HAZARDOUS	MACHINE CHARGE
1. Low	16	.....	....	.....	.....
2. Ordinary	20	.....	....	.....	.....
3. Average	24	.....	....	.....	.....
4. Above Average	27	4	....	0 over 1.50	4
5. High	30	8	5	5 " 2.50	6
6. Very High	32	12	10	10 " 3.50	8
7. Exceptional	34	16	15	20 " 5.00	10

This method is believed to permit of adjusting wages more fairly and uniformly than other methods which do not take into consideration the elements that are not revealed by time or operation studies. As previously mentioned, these are skill, physical strength, working speed, and working conditions, graded so as to cover all classes of labor from the lowest to the highest.

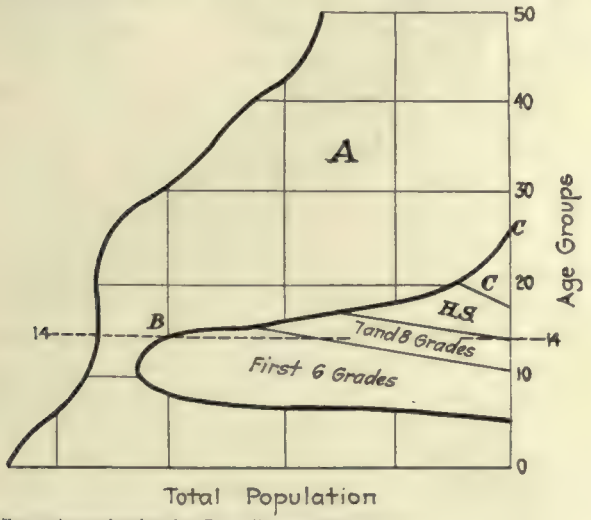
The Contribution of the Continuation School to Industry

By CHARLES W. CLARK

Director, Schenectady Continuation School

WHY, it may be asked, should we bemoan the fact that the once-skilled industrial worker is now ignorant, unreliable, and dissatisfied? Why not admit that his disease can be easily diagnosed as a paralysis of his man-power, brought about when super-efficiency of materials and machines rendered useless his physical and mental equipment? Is it not time that we stopped thinking in terms of things and, by once more placing the emphasis upon the creative urge of every man, raise the standard of effectiveness in American industry, and at the same time provide the coming age with a full quota of thinking men and women?

No manufacturer or any other single agency can expect, however, to restore the intelligent skilled worker to us in full mental and bodily vigor. Nor can the few apprentice schools and trade schools existing in the country today, operated because some individual firm or some wide-awake community has felt its responsibility deeply, hope to effect the cure. The point has now been reached where only by a comprehensive scheme, with all affected agencies contributing their share, can we ever hope to alleviate the present unfortunate condition. Without this concerted effort personnel managers, foremen, and set-up men will try in vain to meet labor turnover, certain plants will develop apprentices who will transfer their skill ungratefully to other employers, and the old shifting and drifting of the labor supply will continue.



From investigation by Russell Sage Foundation

FIG. 1 CHART SHOWING PROPORTION OF SCHOOL ATTENDANCE TO TOTAL POPULATION BY AGE GROUPS AND GRADES

The industrial engineers have given their professional opinion regarding the proper remedy for the trouble, and on the strength of their success in bringing about the highest efficiency of materials, machines, and methods, they have proceeded to build and develop their vestibule training departments and their foremen-training classes, with the hope that perhaps they may provide a homeopathing dose of vocational training to aid in the cure. But not until industry discovers the reason for the failure of American education to prepare workers with greater vocational intelligence and aptitude will it be possible to get at the root of the trouble, and not until then can we arrive at the comprehensive educational effort necessary.

A Basic Education Lacking

Industry is vitally affected by the purposes and methods of elementary education, and with these it cannot afford to be unacquainted. Yet to show industry that our elementary educational system was failing to provide workers prepared to handle their jobs intelligently required the World War, when the rapidly decreasing supply of skilled workers of the old school, further decreased by those who went into the service, made it necessary to train numbers from the non-mechanical occupations. It is time for industry to demand representation on school boards in order that educational programs may be leavened with the ideas of men well acquainted with the needs of our industrial society.

In May, 1920, H. E. Miles, of the National Association of Manufacturers, in speaking before the National Citizens' Conference on Education at Washington, made the significant statement that "it is no longer possible for business to leave the public schools out of their program." He also claimed that the fundamental aim of public school education should be "the development of the social and economic understanding of every individual," and that "half of all our children leave school at the end of the sixth grade." In support of this and other statements he used the chart of the Russell Sage Foundation reproduced in Fig. 1. In this chart the curve at the left represents the distribution of the population in each age-group, and the central curve represents the proportion of the whole population in each age-group attending the various grades of American educational institutions from the primary grades to college. The dotted line at 14 indicates the age at which half of our boys and girls end their education and seek, in their aimless way, a livelihood.

Mr. Miles thus brings out forcibly the fact that only the small proportion of our population between the

dotted line and the line BC has any chance of acquiring an adequate education. The tremendous import of this chart will bear much thought, for if the great body of people represented by the area marked A (except the few who have had a high school and college training) have had no education in the great civic and economic principles, the result could never be otherwise than it is now, when the demagogue has full sway over the minds of workers on so many vital issues. If, in addition, this sixth-grade education has been merely the beginning of an education imperfectly driven home, industry can scarcely expect to receive applicants for employment who are vocationally intelligent to any great degree.

The question may well be asked, why so many leave school without sufficient education. It cannot be that they leave because of poverty, since the American workingman is the best paid in the world. As a matter of fact, less than 50 per cent leave without adequate schooling because of economic necessity. The balance, therefore, leave perhaps because they have found nothing in the education they were receiving which had a vital application. For this the public schools may be censured, and the hope is here expressed that with the greater co-operation of industry our educational curriculum may become more practical. This fact sounds the keynote in the failure of American education fully to meet the situation. Our education has not been and is not democratic so long as 14-year-old children are allowed to drop their education, and others with no greater opportunity are able to go ahead and be prepared for the higher duties of citizenship.

Possible Co-operation between School and Factory

Sporadic attempts have been made in the past to invigorate our curricula by the establishment of manual-training shops, pre-vocational schools, junior high schools, technical vocational and trade high schools, but still the flood of permanent withdrawals has continued seemingly unabated to any great degree. Except where strong attempts at vocational guidance have been made, the offering of vocational courses, elective like those of the high school, has been of slight avail to stem the tide.

However, we have at last arrived at the place where at least in nearly half of the states of the Union it will be possible to provide education more nearly democratic than ever has been the case before. The opportunity is here for industry to secure from the coming generation a class of workers who will be well-grounded, intelligent, and vocationally fit to undergo a short intensive course of training before being assigned to jobs. These people will furthermore be trained in citizenship, in the principles of economics, and the laws of industry.

The opportunity of personnel managers is equally inviting, for by co-operation with the public schools it will be possible to secure a definite statement of the qualifications of each applicant for employment as determined by practical vocational-guidance methods. This will save the sifting process of the factory-training department and permit of early assignment to training for specific work. It will also be possible for industry to find dependable and intelligent workers, so that we shall no longer see a potential baker working as a second-rate machinist or a fine instrument-maker using a pick and shovel through lack of early definition of his vocational aptitudes.

Continuation Schools Essential for Industry

Such a result would be a vital contribution to industry, but to put it into effect industry must do two things: First, recognize the continuation school as a definite part of the present program leading to vestibule schools and foreman-training classes, and on that basis demand certain things of education now within education's power to give; and, secondly, open its gates to educational officials who come with a sincere desire to glean the instructional content of the various trades, so that they may make the workers more capable, and with a sincere desire to follow up their efforts by co-operation with employers in the most effective way. The attitude of the educational authorities will be toward co-operation. Industry will benefit in so far as it meets this attitude with a willingness to carry through the program.

In Wisconsin particularly, business and industry need no introduction to the continuation or part-time school. H. E. Miles, himself a manufacturer, aided most effectively in the first laws passed in that state. Probably employers of New York and other states, where part-time laws went into effect in September, 1920, will see the matter in an equally favorable light if they can have an opportunity to see the full import of the program. If they will look upon it especially as the chance for America to attain a fuller measure of real manpower efficiency, they will consider it, as it certainly is, the most constructive piece of industrial educational legislation yet enacted. Though it may cause momentary hardship, due chiefly to misunderstandings, the far-sighted employer everywhere should welcome the challenge to industry to aid in this vital phase of vocational education.

Ways in which the Employer May Help

Every employer who wishes to benefit by the continuation school will do these things in the beginning. First, he will comb his records for the names of all employees who are 14, 15, or 16 years of age in September, which will be the school requirement in most New York state cities this year. Second, he will send these pupils and all others of these ages he may employ thereafter to register at the continuation school if they have not already done so. Third, after ascertaining through co-operation with the director which is the best half-day for each pupil to attend, he will send them at the stated time and will pay them for the time they attend, as is the policy of the General Electric Company and the American Locomotive Company. Fourth, as a matter of good business he will demand results, and to this end he will frequently visit the school, which is

really his school in common with all the taxpayers, and suggest ways in which the courses offered may be improved. Finally, he will keep account of the lost time of pupils through the school records, and with the backing of the school he should be able to develop a corps of employees who are dependable and regular both at school and at work.

No special emphasis need be directed toward the fact that employers should first become familiar with the law itself. In reading the law they must look upon it as a measure to be backed with the full power of industry, because in it is the hope of a new day for the American worker. The provisions of the law are mandatory, as they must be while there is lax enforcement and occasional indifference on the part of both parents and employers. For the normal parent and employer, however, the law is a piece of beneficent legislation passed by our democracy in order that our children may have the full measure of opportunity, or in other words that our employees may be trained to a higher degree of usefulness than ever before. The four hours of weekly attendance required of minors is incidental to this purpose, and it will be only a short time before both parents and employers will demand mandatory enforcement of the present merely permissive regulation allowing 8 hours of instruction weekly, as was the case in Wisconsin when the full significance of the part-time school became evident.

PERSONAL NEEDS MET BY CONTINUATION SCHOOL

It is time now for the skeptic to question how much of value can be achieved in a weekly 4-hour session. The answer of one of our teachers to a Schenectady employer is worthy of being quoted: "Do you not think that some good must result if a boy sits down one hour each night for four nights each week and practices letter-writing after approved models, does some reading of the best authors, looks up some information regarding his occupation and absorbs it, does some arithmetic related to his daily occupational problems, studies American history and government, becomes versed in the fundamentals of economics and practices daily, after reading the basic laws of health?" Naturally there was only one answer, and the teacher went on to explain that continuation school instruction must be more beneficial than self-education, because of the teacher's power of selection of material and skill in presenting it.

The continuation school has the most flexible curriculum of any public school. Consequently it may readily fit into a scheme of instruction which would use the continuation school for the development of vocational intelligence and for training in the vocational fundamental of accuracy, leaving the development of speed and skill to the factory-training department. Continuation school courses are arranged to meet the needs of the future workers as defined by the occupations of the community. Thus, in a community like Schenectady, where over 50 per cent of the boys will ultimately enter the metal-working trades, the chief emphasis is laid upon the metal-working phase of shop-work. At the same time, however, tryout as well as trade preparatory courses are open to those who will enter the building trades. What industry should understand clearly is that the continuation school can do its best work when the courses are determined and moulded, not by the ideas of individual teachers, but by the actual occupational requirements.

TRAINING FOR CITIZENSHIP AS WELL AS FOR INDUSTRY

We have said that the pupils who leave school at the sixth grade receive no instruction that would give them an intelligent understanding of civic and economic conditions. This knowledge is quite as vital to the success of our democracy as that our college men should know the basis of our governmental institutions and the fundamentals of great economic fluctuations. Accordingly a wise provision of the New York State law requires that American history, the rights and obligations of citizenship, industrial history, economics and the laws of industry, form part of the continuation school curriculum. For the rest, wide latitude is given in "such subjects as will enlarge the vocational intelligence of minors." Employers must see the significance of training in citizenship and economics. By such means it is fairly certain that the coming generation of workers will be independent thinkers, will be able to understand the problems of the employer to such an extent that the sole requirement for him will be to play fair in order to bring about a healthy satisfaction and the much-to-be-desired morale in his organization.

Lest the impression be gained that the writer is classing as unimportant the elementary education of the first six years, let it be said that the continuation school work must be built upon that very foundation. Many pupils will have had additional education, perhaps through the second year of high school, and for such pupils advanced work must be provided. For the large numbers who will not have graduated from the grade schools, however, and who have had no opportunity to use their elementary education, the mission of the continuation school will be to conserve and apply the three R's already acquired. The value of the well-written business letter, the application of arithmetic to daily occupational problems, the application of hygiene to personal appearance, the benefits accruing from a correct use of the English language—all these thus translated into daily needs have a new meaning for the pupil.

CONTINUATION SCHOOLS AID VOCATIONAL GUIDANCE

Perhaps the fundamental value of the continuation school comes from its vocational-guidance feature. No better illustration of the possibilities for vocational guidance could be given than the situation in Schenectady. There are considerably over 200 pupils of both sexes who are employees of the great works of the General Electric Company. By far the majority of these are boys, and of these the great majority of the ages now required to attend continuation school are messengers and office-boys. The great part of these in turn

have aspirations to become toolmakers and expert machinists, chiefly because they know the wages paid the skilled journeyman. As there are only about 150 apprentices taken in the apprentice courses of both the General Electric and American Locomotive Companies each year, and there are over 1,000 potential aspirants, clearly some must be led into useful work in other, perhaps allied trades, if they are to be saved from becoming the driftwood of the future labor market. These boys, then, will be made acquainted with the occupational possibilities of the community and with as much of the details of each occupation as there is material available. Furthermore, they will be permitted to take tryout courses in the various shops, where they will be taught the fundamentals of the root trades, without emphasis upon specialization. In this way they may discover their own aptitudes and eventually be led to a vocational decision, perhaps, by the age of 16, when they are permitted greater freedom in factory work by law.

PLACEMENT SERVICE ASSISTS EMPLOYMENT MANAGERS

The continuation school has thus re-established these pupils on a plane where their elementary education is once more useful. It has opened their eyes to occupational opportunities. It has tested for them their aptitudes, and perhaps has led them to make a definite choice of vocation. The school records show each pupil's progress and qualifications, based on an intimate acquaintance in the classroom, in the home, and on the job. Does it not seem reasonable, then, to believe that where this program is carried out effectively with the full backing of every industry, the continuation school can, with a certain amount of assurance, recommend to employment managers certain pupils for unfilled jobs? A willingness on the part of employment managers to supply continuation school directors with job specifications will aid materially in the selection, from all the available unemployed labor in the 14-18 age group in any community, of the most desirable applicants from the viewpoint of actual attainment in the school.

An important feature, therefore, of the continuation school program is the placement service. Employers will gradually come to realize that if they want accurate information from reliable sources regarding any applicant who is at present in continuation school or one who has finished the course, a telephone call to the director will bring a prompt and courteous answer. Gradually, too, employers will come to see that the continuation school is a fountain head through which all minors who do not graduate from high school should pass. Then they will requisition their juvenile labor directly through the continuation school office and secure effective service. Here, if he employs juvenile labor, is the opportunity of the employer, whether he own a grocery store or an automobile factory.

This comprehensive scheme here briefly described will assure a supply of workers who know the fundamentals of their selected occupation whether they are assigned to a highly specialized job or not. The plan is not an original one evolved from non-existent agencies; it is only held to be a full utilization of present facilities brought about by a co-ordination now rendered possible by the linking up of the continuation school in the chain. By this scheme, which may be very simply stated, each individual will, as before, receive through the elementary school the basic education on which to build what follows. We may wish to change the character of this fundamental training as circumstances may later direct, but the principle will remain the same.

The next step will be the academic high school for those scheduled for the professions and the vocational high school for those of more practical turn of mind who still wish the benefits of a high school course. By this time, however, the greater number of young Americans will wish to be independent, and for them, will stand ready the continuation school, where they will undergo the type of training outlined above. As a result of the co-operation of employers with the school, the young worker should come to the job with desirable habits already developed, leaving to the employer merely the task of training him in speed and in the particular technology of a specialized operation. Later on it will also be the employer's task to develop their potentialities for future foremanships.

AN EFFECTIVE EDUCATION FOR INDUSTRY

The plan, however, does not stop here, but goes on and is still in the province of the employer's interest. We have asked before what becomes each year of the great number of aspirants for apprenticeships who cannot possibly be entered. They have been helped to the limit of possibility in the continuation school, and they are now employed as operators of automatic and semiautomatic machines. They have been educated in the fundamentals of mechanisms, in mathematics, in subjects of cultural value and social value, in history, in economics. They are the thinking, intelligent workers asked for 10 or 15 years ago, when only driftwood added to the employer's turnover. Will it be possible to retain such an enlightened employee at monotonous tasks? Of course not. Neither on the other hand will it be possible for all to become foremen and executives. It will be to the interest then of every employer to adopt a uniform policy of promotion and transfer and put it into operation as he never has before. Transfers will be made, not because of inefficiency but in order to develop a corps of all-round employees who will be faithful, satisfied, capable producers, and worthy citizens. This state of affairs for which industrial leaders have so earnestly wished, may be brought to pass provided employers will proceed to interest themselves actively in public education, and especially in this new and vital feature now being developed over half the United States, the continuation or part-time school. Secondly, it will be brought to pass if employers follow up the training in intelligence provided in the public schools by a well-defined program in industry to ameliorate the drudgery of routine occupations and cater by all means within their power to the creative instinct and the individuality of each employee.

Standardizing the "Z" Chart

To Permit of Its Production in Quantity

By ARTHUR R. BURNET

Consultant in Business Statistics

STANDARDIZATION in products and in methods of production as a means of eliminating waste and lowering cost is a basic principle that has been applied by many noteworthy industrial enterprises. It is not strange, then, that this principle, so fervently preached by management engineers, should also be applied to that modern tool of the business administrator, graphic methods.

The present article does not propose to treat the entire subject, which must some day be threshed out by a group of interested experts, but confines itself to the standardizing of a particular type of management engineering chart, known as the "Z" chart, which is being used successfully to control production, costs, sales, and finance. As was explained in a previous article by the writer,[1] the chart has been given its name because the three curves of which it is composed often take a shape resembling the letter Z. Standardized methods have brought chart-making within the ability of the office clerk.

Selection of the Paper

The first step in the standardizing of the Z chart is the selection of the paper. The market has been searched for the stiffest, whitest and yet most translucent paper of commercial size and manufacture. The paper stock chosen is heavy enough to stand up in an office filing cabinet, and yet not too heavy to be placed in a ring binder or to allow the curves of two charts to be compared when one is superimposed on the other, and both held against the light.

The standard 8½ in. by 11 in. sheet is chosen because it fits all regular filing devices and office appliances, and especially because it permits the use of a narrow carriage typewriter for the recording of the data and all necessary information.

Wide carriage machines are slower, more expensive and not always available. Experience has proved that small cards or large sheets, while useful for special cases, are troublesome and awkward in an actual graphic control system. The business world by common consent has fixed upon the 8½ in. by 11 in. page as standard.

There are several major considerations in determining upon the size and position of the co-ordinate field, chief of which are:

1. Since the data and other written information are to be typed, the dimensions must be adapted to the standard narrow carriage typewriter found in all offices. Wide carriage machines, special type and other irregularities are to be avoided.

2. The co-ordinate field must be located so as to provide the maximum of typing space without removing the chart from the machine.

3. The width of the field from left to right, or in the direction of the time scale, is determined by the worst possible case, namely, the typing of a year-by-weeks chart on a regular pica or large type machine. By experiment it is clear that the ordinates can be placed no closer than ⅛ in. Fifty-two times ⅛ in. equals 6½ in., which is therefore fixed or standardized as the width of the field for all charts, whether weekly or monthly.

Thus the horizontal dimension is determined. The 4-in. height is arrived at likewise as the result of experiment. It has been found upon examining a good many thousand charts that very few of the curves need go above 4 in. during the period of ordinary usefulness. Why waste the space, especially since it is in demand for the data? The margins at the bottom and to the right are made only ¼ in. wide in order to bring the curves of one chart close to those of another when two charts are overlapped either vertically or horizontally.

After the dimensions of the chart form are established, it will be observed that the clear spaces to the left and at the top of the field are equal in width. This is distinctly in favor of the appearance and balance of the chart. An interesting, though minor, fact about the proportions of the field is that they closely approach the "Golden Mean" of the Greeks, that is, the proportions which Greek architects regarded as the most pleasing to the eye.

Omission of Intermediate Rulings

Engineers and others accustomed to the use of co-ordinate paper will at once remark on the absence of "intermediate rulings," i.e., lines drawn 5, 10, or 20 to the inch, as found in commercial plotting paper. The only horizontal lines printed in the field space of the Z chart form shown in Fig. 1 are the zero and inch lines. There are several good reasons for omitting the intermediate rulings:

1. Since the engineer's scale is used for measuring vertical distances on the field, such rulings are not required for plotting.

2. Their omission means that less paper has to be carried in stock. If intermediate rulings were used there would have to be a set of forms with appropriate

[1] See Management Engineering for August, 1921, p. 83.

rulings for each of the three sides of the engineer's scale, and one set would always be inconveniently out of stock. The standardized charts shown in this article avoid that trouble.

3. The absence of intermediate rulings makes it possible to introduce other horizontal lines for special purposes, as, for example, lines representing percentages drawn on a field representing absolute values, or

The spacing card (Fig. 1) provides a definite location for every element that appears on the chart and is therefore a valuable device for standardizing the Z chart. It is an illustration of the old adage: "A place for everything, and everything in its place." This not only saves time, but results in uniform and neat appearing work, and is particularly desirable in view of the fact that these charts are made in large numbers

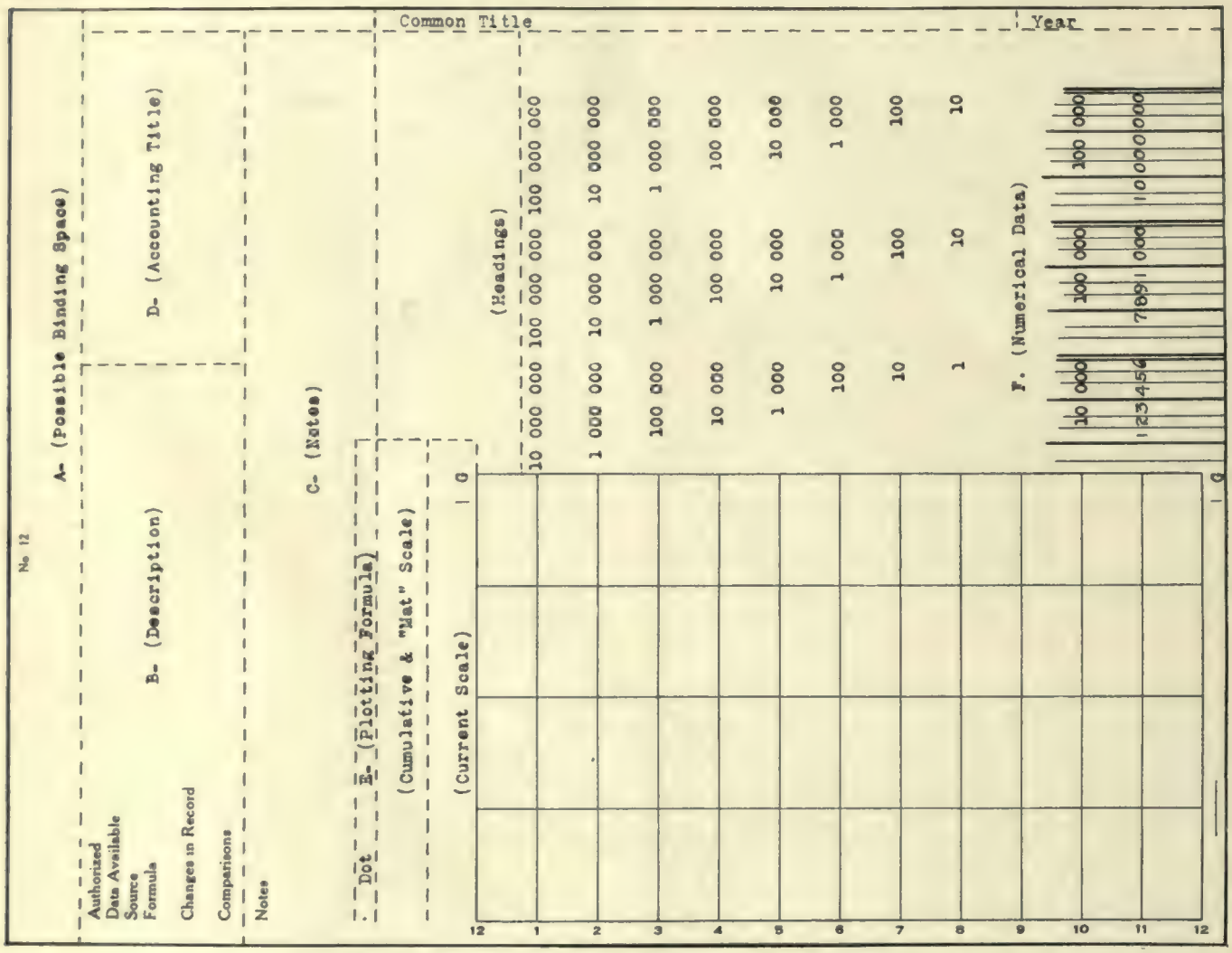


FIG. 1 SPACING CARD FOR STANDARDIZING THE Z CHART

The typist uses this model form to set the tabular stops on the machine, and to locate the various elements of the chart. The result is speed and low cost of production. A standardized chart enables the executive to place his finger at once on the information that he needs. The charts are designed to fit the ordinary typewriter, and most of the typing can be done without changing the position of the sheet. The common title and the date can be written by hand if necessary. The accounting title contains the exact information needed for filing.

vice versa. There would be hopeless confusion if these special horizontal lines had to be placed among intermediate rulings.

4. The omission of the intermediate rulings is a distinct advantage to the eyesight of those who make and read the charts. This especially applies to the year-by-weeks charts. Many charts published in books and magazines give the observer a blurred impression on account of the multiplicity of useless rulings. In this connection, the charts of the *Review of Economic Statistics*, published by the Harvard University Committee on Economic Research, are worthy of special mention as fine examples of clear-cut graphic representation.

by ordinary typists and office clerks. Charts that have been drawn according to standard spacing will "match up" when placed side by side. In other words, the data will appear in line, as well as the scale figures, formulas, and titles, and time will therefore be saved both in constructing the charts, and in reading them, due to the simple fact that the eye becomes accustomed to looking for certain things in the same spot.

Each typist or person engaged in making and posting the charts has a spacing card for ready reference. The elements and locations appearing on the card are self-explanatory, but a few points, perhaps, need emphasis. For the sake of brevity they are referred

to below by designating letters corresponding to the letters in Fig. 1.

A—Binding Space. To be used when the charts are kept in ring binders. It is more desirable, however, to keep them in filing cabinets properly separated by index guides.

B—Description. A collective name for the six items printed here. It is really a description of the chief shrinkage, plus freight." "Comparisons" refers to graphic comparisons. From time to time an unsuspected relation between one chart and another is discovered. Such discoveries are too valuable to be lost and should be recorded.

C—Notes. Reasons and explanations of specific peaks and valleys appearing on the individual chart. Even the best operating executives forget important

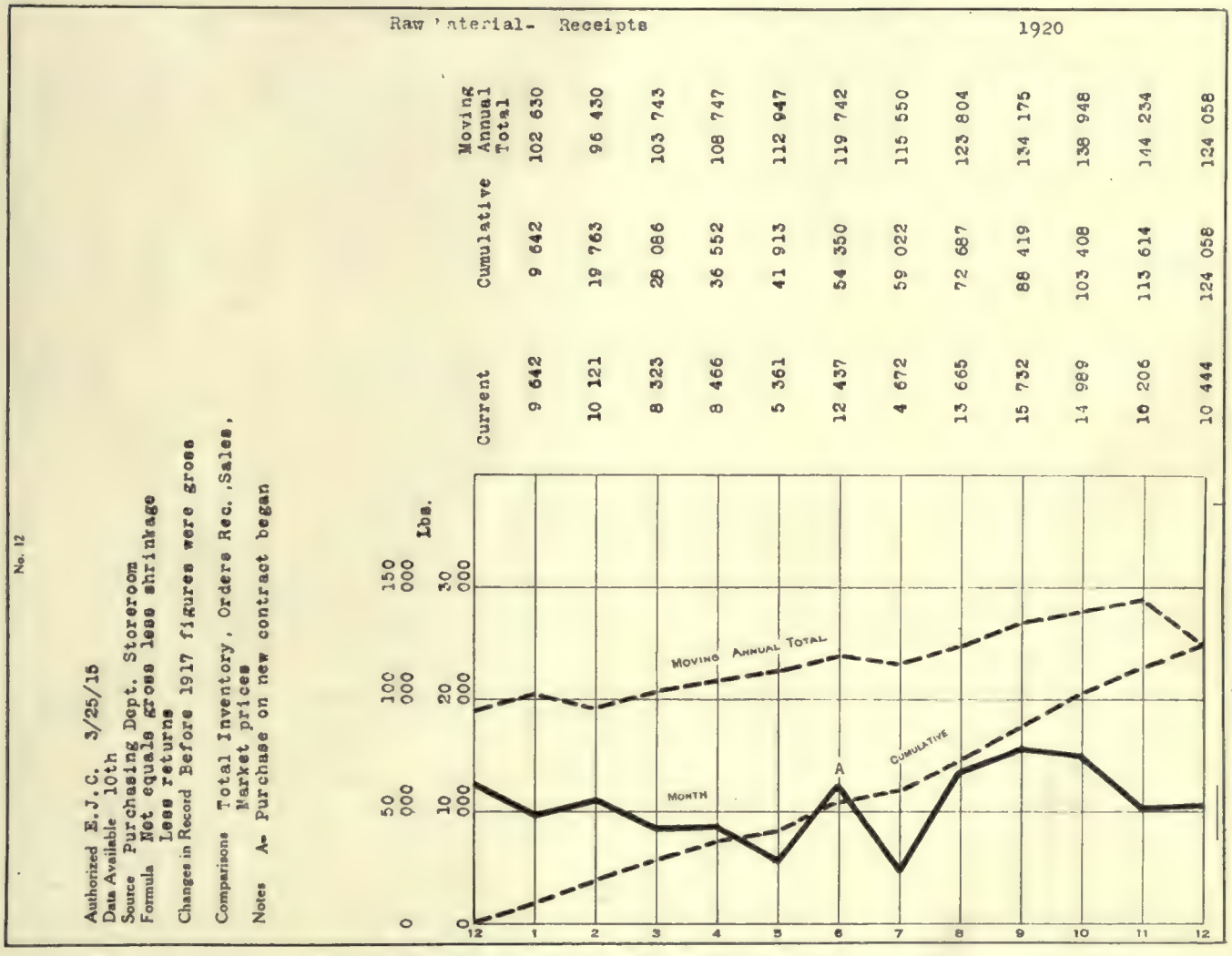

Raw Material- Receipts
1920
No. 12
Authorized E.J.C. 3/25/15
Data Available 10th
Source Purchasing Dept. Storeroom
Formula Net equals gross less shrinkage
Less returns
Changes in Record Before 1917 figures were gross
Comparisons Total Inventory, Orders Rec., Sales, Market prices
Notes A- Purchase on new contract began
Current
Cumulative
Moving Annual Total
9 642 9 642 102 630
10 121 19 763 96 430
8 323 28 086 103 743
8 466 36 552 108 747
5 361 41 913 112 947
12 437 54 350 119 742
4 672 59 022 115 550
13 665 72 687 123 804
15 732 88 419 134 175
14 989 103 408 138 948
10 206 113 614 144 234
10 444 124 058 124 058
Lbs.
150 000
100 000
50 000
0
30 000
20 000
10 000
0
MOVING ANNUAL TOTAL
CUMULATIVE
MONTH
A
12 1 2 3 4 5 6 7 8 9 10 11 12

FIG. 2 CHART SHOWING RAW MATERIAL RECEIPTS

This chart can be studied alone or in connection with the Consumption and Balance Charts in Figs. 3 and 4, which together make a complete set of "materials control charts." Note that they are all drawn on the same scale, i.e., any vertical distance on one chart represents the same number of pounds on all three. We can see the amount received this month (current monthly curve) or the amount since the beginning of the year (cumulative curve) or the amount received during the past 12 months at the end of any month (moving annual total curve). A large number of useful comparisons are therefore possible between this and other charts. Charts of this kind are applied to raw material, and finished goods control, expected and actual receipts and expenditures.

characteristics of the group of charts to which an individual chart belongs. This list includes important information needed for the intelligent reading of the chart. Who among us has not been in a conference when the discussion was halted by somebody that wanted to know where the figures came from, how they were compiled, and whether or not they contained a certain item? The description supplies the answers in advance. By "Formula" is meant the accounting make-up of the figures. It shows exactly what has been included and what excluded, e.g., "net equals gross less

events that have disturbed the even tenor of their industry, and the same events are likely to recur.

D—Accounting Title. An exact scientific title used for the purpose of filing and careful analysis. The "common title" is the name by which the chart is commonly known, and is a shorter and less exact designation than the accounting title. The distinction between the two is very much like the difference between the common and scientific names of flowers. A system of filing large numbers of graphic control charts has been worked out by means of which the charts are not

only found quickly but the very arrangement of the charts in the files suggests useful comparisons. The accounting title itself provides the foundation for the filing scheme.

E—Plotting Formula. This is a simple mathematical formula greatly facilitating the plotting of the curves, which is not explained in this article for lack of space. The printed dot indicates where to begin the typing of the formula.

F—Numerical Data. The figures are arranged to show the setting of the tabulator stops on the typewriter. Some chart forms have regular accounting rulings as is suggested on the spacing card. If desirable the figures can be entered in handwriting by the accounting department, and afterwards plotted by the graphic department. In certain cases this may save considerable time.

G—Ticks. Short lines to show where to overlap one chart upon another when it is necessary to combine fields. Multiple fields, however, are only used in rare cases.

Examples of standardized Z charts are seen in Figs. 2 and 3, which in conjunction with the chart of Fig. 4 forms an interesting group known as Materials Control Charts. They were given this name because they were first applied to the control of raw materials, a subject which today is receiving a great deal of attention on the part of management engineers. They have been applied to many other subjects that can be considered from the point of view of receipts, consumption, and balance, or, as the accountant would say: "debits, credits, and balance." Such subjects are supplies, machine parts not yet assembled, branch office inventories, cash, etc. The Materials Control Charts are fully described here, because, taken together with the examples and discussion in a previous article,[1] they

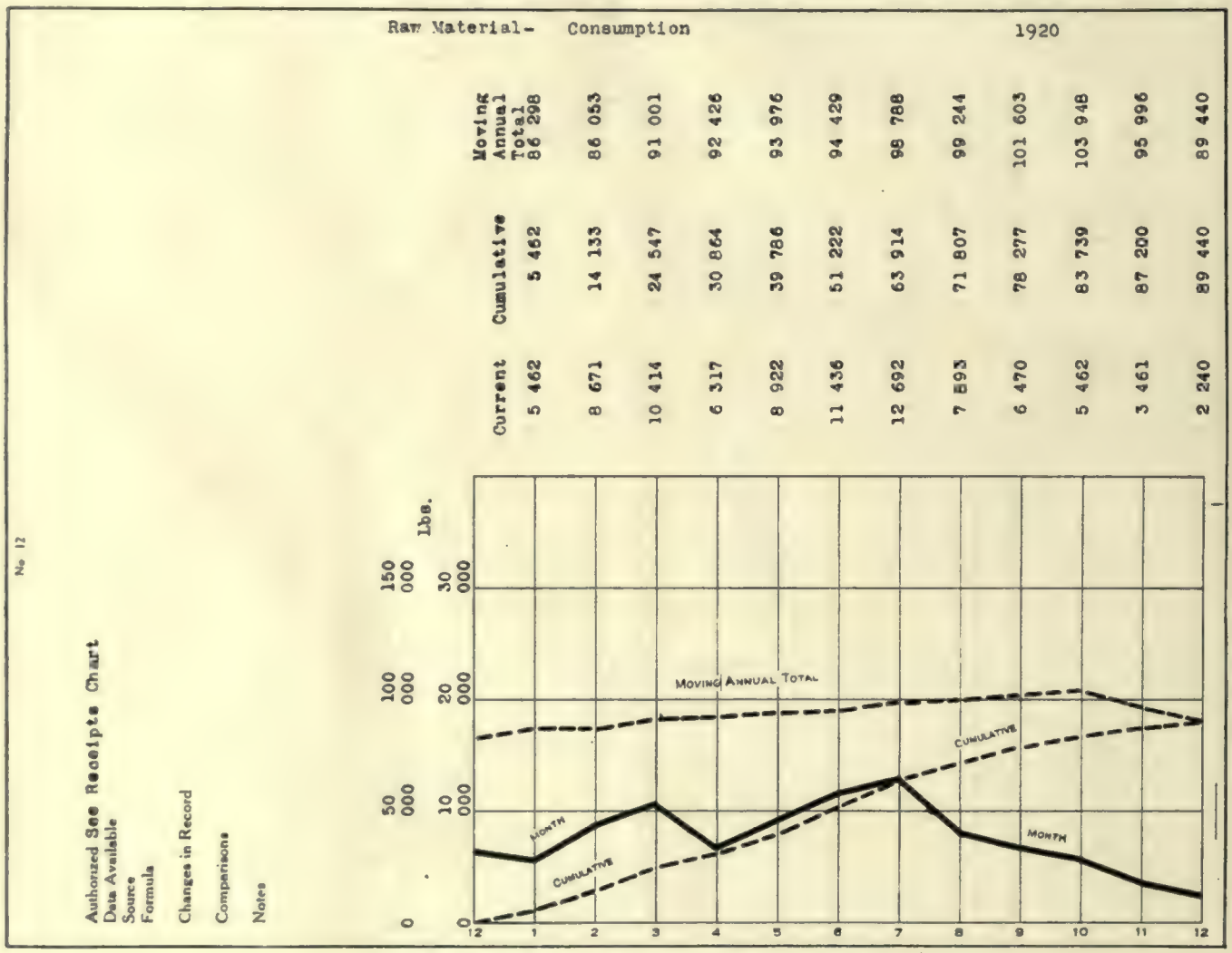


FIG. 3 CHART SHOWING RAW MATERIAL CONSUMPTION

A set of three materials control charts is drawn for each individual raw material, such as iron ore, linseed oil, rubber, etc. These three charts illustrate well the reason for plotting a single subject on one chart, for there would be hopeless confusion if the curves of the other two charts were also drawn on this chart. The executive can see at a glance whether the consumption is regular or irregular, or whether it conforms to a seasonal fluctuation or some other standard shape of curve peculiar to the industry. The study of the materials control charts, especially in connection with the other control charts of the same enterprise, is an effective means of eliminating waste.

[1] See MANAGEMENT ENGINEERING for August, 1921, p. 83.

demonstrate that Z charts can be applied to every phase of industrial activity.

Materials Control Charts are usually drawn in sets of three on separate sheets: (1) receipts or accession of material, (2) consumption, withdrawal, usage or requisition of material from stock, (3) balance remaining in stock. The charts recording receipts and consumption are of the standard Z form, whether the unit of time be weeks, months, or other periods. The balance chart contains a single set of figures plotted on both the current and the cumulative scales. The curve plotted on the cumulative scale is here indicated by the broken line, but in the original it was drawn in red, as were also the cumulative and moving annual total curves of the other two charts. Thus it becomes easy to compare black lines with black, and red lines with red.

The matter of scale selection is taken care of by the standard scale selection tables with which each clerk is supplied. It is sufficient to point out here that the consumption figures determine the scales for all three charts, since consumption is a better measure of productive activity than are receipts or balance. It makes little difference whether the upper curve of the balance chart runs off the top of the field since the lower line always remains on the field. When the balance falls so much that the lower line approaches zero, and becomes very flat, the upper line will show sufficient fluctuation. Under ordinary circumstances the upper line running off the field will probably indicate an excessively large inventory, while the approach of the lower line to zero is likely to indicate too small a balance. If necessary a second field can be overlapped on the first by using the ticks as explained above.

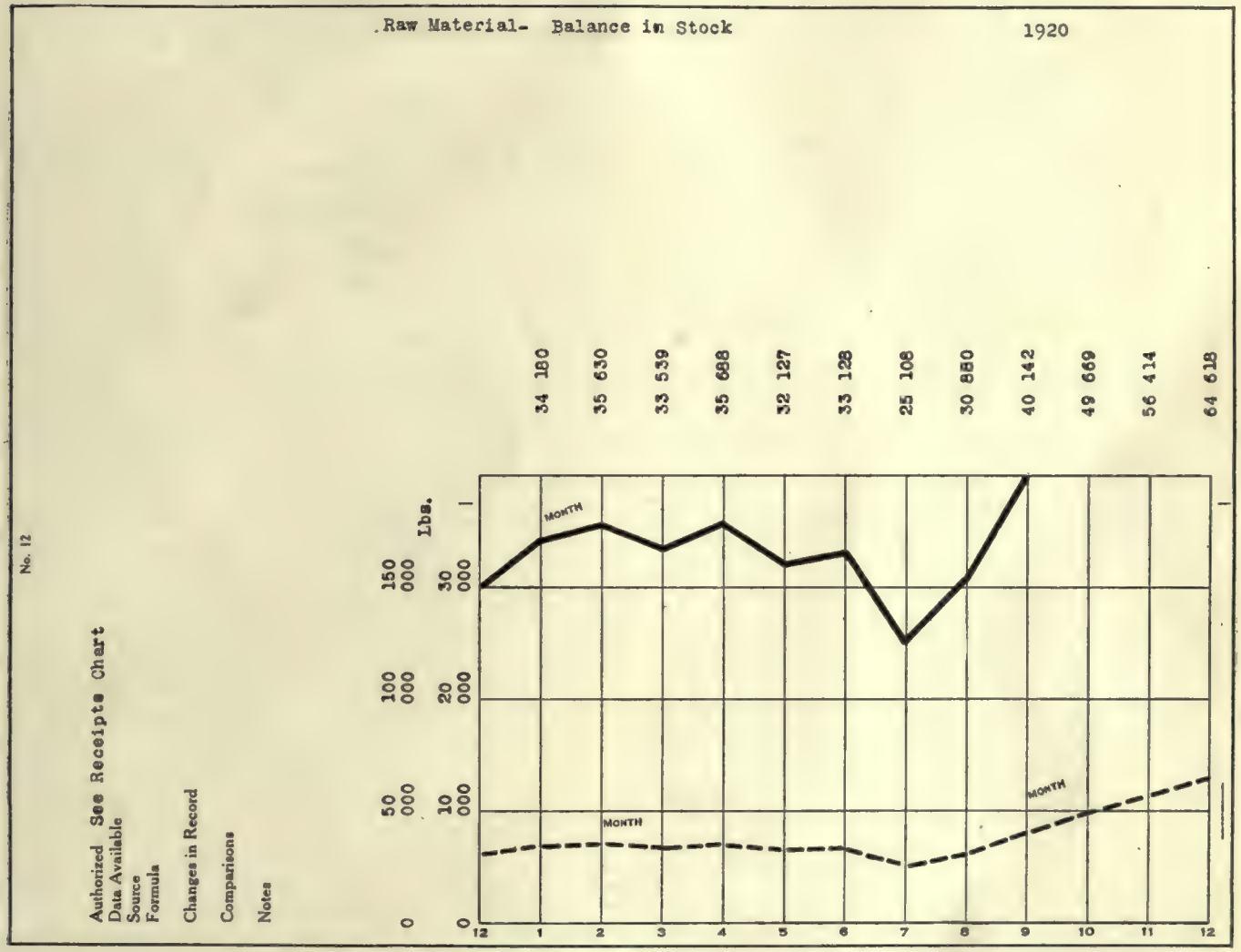


FIG. 4 CHART SHOWING RAW MATERIAL BALANCE IN STOCK

The monthly record of stock on hand. A single column of figures is plotted on two scales corresponding to the scales of the charts in Figs. 2 and 3. It is therefore possible to compare directly the height of the solid curve of this chart with the height of the solid curves of the other two charts, and to make similar comparisons between the broken curves. Maximum and minimum limits are set by drawing danger lines, above or below which the curves should not go. The executive need not worry about inventory unless his attention is called to curves that have exceeded the limits. Charts of this kind are used with great success to reduce inventory, because the relation to receipts and consumption can be so easily watched.

For the control of materials these charts are particularly valuable because they are more than dead records of the past. The comparison of one chart with another or the simple inspection of the curves will

show present trends, ratios, and vital relationships, and furnish estimates of the future even before computations can be made.

Several uses of the charts, Figs. 2 to 4, are suggested in the brief summary that follows. Most of the comparisons are made by putting one chart over the other, and holding the two against the light.

How the Charts Are Used

1. Compare receipts and consumption by means of the three curves. The annual rate of receipts is greater than that of consumption, while the two have followed each other closely during the first eight months of the current year. The monthly curve of the consumption chart shows considerable irregularity.

2. Compare the average balance for the year (as shown by the average height of the lower balance curve) with the moving annual total curve of the consumption chart. It is seen that stock has been "turned over" about two and a half times during the year.

3. Compare the average monthly consumption (as shown by the current monthly curve) with the upper curve on the balance chart. Thus, in August there was more than three months' supply on hand, judging by the number of times the average height of the consumption curve for the first eight months goes into the height of the upper balance curve at the August point.

4. By means of a pencil line, plot ahead the cumulative curves for any uncompleted year so as to show a graphic record of the expected receipts and consumption. The curves so drawn can be compared with the actual receipts and consumption curves later on, or they can be compared with the actual receipts and consumption of a previous year, making due allowance, naturally, for necessary increases or decreases in production. The plotting ahead of expected receipts and consumption is being used today by many productive industries to control raw material purchases, and to regulate shipments from stock. It is becoming fashionable now to apply quotas to sales and to "budget" expenses; why not apply the principle to inventory? Some companies have already successfully used graphic methods for this purpose. In describing the charting of statistics at the plant of the Winchester Repeating Arms Company, *The Iron Age* for January 24, 1918, said:

> At an expense of a little more than $12,000 a year for maintenance of the department, a single result that has accrued from its work has been the cutting in half of the inventory, a matter of several millions of dollars net gain.

The set of charts (Figs. 2 to 4) is sometimes effectively applied to the measurement of labor turnover. The "receipts chart" can be used to represent "hired," the "consumption chart" to represent "fired," and the "balance chart" to represent "enrolled." It will not make any difference, then, whether we wish to compute the percentage of turnover by means of the "hired" or of the "fired"—the charts can be used equally well either way.

A good illustration of the executive use of standardized control charts is furnished by the general manager of a large industry having plants in various parts of the country. The manager is obliged to be away from his office more than half of the time. But after each trip, or about once a month, he spends parts of two days looking over the most important charts, from which he finds out exactly what has happened during his absence. He can tell instantly whether expenses are increasing faster than sales, which territory or commodity is slowing up, or how production, cost or any other factor fell short of or surpassed expectations.

Organization in industry *658.3*

The Effect of Standardized Procedure on Organization

By C. L. WHITE and G. J. PERRY
With the Pierce-Arrow Motor Car Company

ALL lines of human endeavor, whether they be the operations necessary to the maintenance of a home or those in a large industrial plant, are composed of a concrete mass of detail, which, when assigned to individuals, becomes responsibilities, and the result is an organization. Responsibilities may be divided into two general classes, as follows:

1. Major or functional responsibilities which have to do directly with the production of the product.
2. Minor or subsidiary responsibilities which have to do with the system or method for the production of the product. This second class of of responsibilities comprises:
   - (*a*) Paperwork for receiving, recording, disbursing information.
   - (*b*) Movement of all paperwork.
   - (*c*) Scheduling of all productive efforts.
   - (*d*) Movement of all material.
   - (*e*) Personnel control.

As an example of the above analysis, the finance responsibilities of a company may be cited. In this case the major or functional responsibilities of the group have to do with the collecting and disbursing of funds or banking and general financial relations, while the minor or subsidiary responsibilities have to do with the accounting, bookkeeping, billing, record keeping, paying of employees, etc.

According to modern organization principles, responsibilities must be:

1. Definitely placed, or assigned to individuals.
2. Classified and assigned according to the specialized knowledge of individuals.
3. Classified and assigned according to the needs of administrative control.

In other words, any individual must have those subsidiary responsibilities which are contingent to his major functional responsibilities, as, the individual in charge of the finance group of responsibilities should have the accounting, bookkeeping, billing and record-keeping responsibilities in order to function properly.

There are seven fundamental groups of responsibili-

ties in an industrial organization: financing, engineering, purchasing, manufacturing, distributing, maintenance of plant and equipment, and industrial relations. The latter includes employment, health, and safety.

Modern organization principles further divide each one of these fundamental groups of responsibilities into the divisional, departmental, and sectional groups. In the last analysis every responsibility, major or minor, should be functionally assigned to some individual. Therefore, in the ideal organization, all of the minor or subsidiary responsibilities should be made to become functional responsibilities.

The extent to which the fundamental responsibilities are split up into divisions, departments, and sections depends on the size of the organization, the conditions of plant layout, material flow through the plant and personnel. In a small concern, the office manager may be responsible for the purchasing of all material and the hiring of the help. The sales manager may also be the traffic manager and be in charge of receiving; or all these responsibilities may be assigned to the same individual. However, the fact remains that, although the organization is small, it still has its fundamental groups of major functional responsibilities with their subsidiary detailed duties, which must be definitely assigned to individuals. If this is not done, we will have present in our organization what is commonly called "passing the buck" and "short-circuiting of orders," which conditions have a negative effect on the efficiency and morale of the whole organization.

Minor executives of all organizations have a tendency to see and assume only those major responsibilities which have to do with the productive effort of their department. They often have a disdain for system and method and for this reason have built up around them, because of the lack of analytical thought and failure properly to assign minor responsibilities, a cumbersome mass of red tape and system.

Authority Should Accompany Responsibility

It is generally conceded that with responsibility should go the authority to accomplish the work for which the individual is held responsible, and the reverse is, of course, also true. In an efficient organization it is therefore necessary:

1. That responsibilities be properly analyzed, classified, and assigned.
2. That necessary authority be delegated to individuals, who have been given responsibility.
3. That, inasmuch as a large percentage of minor executives are not organizers, they be assisted in this work.
4. That the lines of authority be clearly defined and legislated by means of an organization personnel chart.
5. That in the placing of responsibility—the method of doing business within their department, including paper work records, material movement, etc.—they be clearly defined, legislated, and recorded by means of standardized procedures.

This work is best accomplished by an industrial analyst, who should work from a neutral position on the staff of the management. He should be given no executive responsibility and, therefore, no executive authority. His results should be gained by suggestion rather than by pressure. His analysis should clearly show the defects, after which he merely suggests and sells the remedy to all concerned and legislates it, over their signatures of approval, in the form of a procedure. The procedure is the means for introducing the new system and should clearly accomplish this end.

How a Standardized Procedure Should Be Created

In the development of a procedure, the analyst must follow certain fundamental rules, as follows:

1. He must sell himself to the executives of the department on the following points:
   - (*a*) That he is not there in the capacity of an "official squealer" to the mangement, but to help them in planning those details of their department which they have not the time, inclination, or possibly the training to perfect.
   - (*b*) That this purpose is not to make changes, but merely to analyze and record the present system in order to:
     1. Strengthen the administrative control of the organization as a whole.
     2. Assist and instruct new employees coming into the department.
     3. Provide a basis for rearranging the system quickly and efficiently to meet new conditions which may arise.
   - (*c*) That all changes for betterment within their department, due to his work, will be made over their own signature, they thereby getting the credit for all improvements effected.
   - (*d*) That he is in a position, because of his neutral position and knowledge of the system in other departments, materially to assist them in any of their interdepartmental relationships which they have had difficulty in getting adjusted.
   - (*e*) That he will not take anything over their heads, but will always consult them. The analyst, of course, reserves the right to bring pressure on executives who will not listen to reason.
2. Having thoroughly sold himself and his work to all the men with whom he comes in contact, the industrial analyist now has free access to all the information which he will need, and proceeds to analyze each department, in general, as follows:
   - (*a*) Personnel.
   - (*b*) Operations performed.
   - (*c*) Procedure, covering:
     1. Paper work—following each piece from the initiation of its destination and final disposal.

2. Information received and disbursed.
3. Records.
4. Methods.

(*d*) Co-ordination with other departments.
(*e*) Responsibilities.
1. Major or functional.
2. Minor or subsidiary.
3. How placed, according to personnel.

(*f*) Executive roports.

3. Having made notes of all complaints and suggestions, the analyist now studies carefully each point, making note of all weak points.
4. He then gets in touch with the executive concerned and carefully brings out these weak points, at the same time leading him to suggest plans for betterment.
5. Having secured the ideas and opinions of all concerned, he now draws up a rough procedure in which is incorporated all suggested changes.
6. He routes this procedure through the hands to all concerned, requesting that they read, correct, and make any suggestions that they desire.
7. He corrects and rewrites the rough procedure and has it reread by the executives concerned.
8. He then writes the official procedure on which he secures the approval signatures of all executives concerned and, when changes of policy are involved, the signature also of the proper officials of the company.
9. He then sees that all necessary arrangements are made to put the revised system into effect and issues copies of the procedure to all concerned.
10. He must put special emphasis on the fact that in developing and initiating a new system or betterment plan in an old organization or department of an old one, it is of the utmost importance that:
(*a*) He make contact with every individual who, in any way, is connected with it.
(*b*) All individual opinions and suggestions be carefully considered.
(*c*) They thoroughly understand and are sold to the new plan.
(*d*) The approval signatures of all executives concerned appear on the official procedure.

Standard Procedure Unearths Defects

The psychological reaction of this program is excellent, as it has the result of focusing every mind in the department on his own system and methods, with the result that defects are unearthed which they only, with their intimate knowledge of their work, could discover.

To draw a simile—a dozen men may be employed in making the units which go into the construction of a gasoline motor. These men may not even know where the particular part on which they are working is used in the motor. Why? Because they have not given the question even a little thought or study; it is out of their line of responsibility. Still their work is very vital to the complete motor. An engineer comes along, and while he may not know how to do all the work necessary on the individual units and may be clumsy with the wrenches needed in the assembling of these parts, still he has a vision of the finished product from the first to the last piece and can guide the proper assembling of the parts, the result being a perfected, finished product.

The Results of a Standardized Procedure

A procedure must clearly define, in proper sequence, the specific routine, processes, methods, and means to be taken to accomplish definite results by human efforts, paper work, system, or movement of material, and must definitely and clearly place all responsibility. In general, then, the development of a procedure results in:

1. Properly classified and definitely assigned responsibilities.
2. Simplified and clarified routine methods and means.
3. Eliminating waste and duplication of effort.
4. Stopping "short-circuiting of orders" and "passing the buck."
5. Stimulating many minds to focus on their own organization and methods.
6. Providing a permanent record of the system for the instruction of the new executives, for the readjustment o fthe system to meet new conditions, and for providing adequate administrative control.
7. Providing the means for the installation of the new routine.

The industrial analyst must, first of all, be capable of analyzing to the most minute detail. He must have vision and foresight; he must be a good judge of men; must be strong enough to hear the complaints and opinions of many men without being too heavily influenced by their opinions; must be absolutely neutral to everybody within the organization without ever betraying the trust and confidence of the management or men; must be familiar with the best organization principles; must always remember that in applying these principles in an old organization the process must usually be slow, and that minor executives must be educated to the new point of view. He must also remember that in any industrial enterprise the organization has to be adapted to and be built around personnel or conditions.

The work of the industrial analyst differs from the work of the industrial engineer in that he assists and guides the industry in doing its own reorganizing work. In other words, the reorganization is from the inside and not from the outside. It is slower in its movement, because growth in the betterment of human and industrial conditions is a matter of evolution and must necessarily be slow.

The results obtained from such staff analysis work as has been outlined in the foregoing are really marvelous and far-reaching. Such work is "safe and sane"—safe because the results in the standardized procedure are not effective until sold to and approved by the executives concerned; sane, because they are not the pet plan of a single mind, but a "working plan," only refined and standardized.

The Gantt Chart—II

Its Application to Man Records and Layouts

By WALLACE CLARK

Consulting Management Engineer

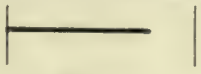
THE purpose of the Man Record Chart is to show whether or not a man does a day's work and, if not, the reason why. The fact, however, that a man took a certain time to do a piece of work is of but little interest until it is compared with the time in which the work could have been done, for by so doing the foreman sees the advantage of making an estimate of the time it should take before the work is actually begun. If he has accurate information, he makes use of it, but if not, he makes as close an estimate as possible based on his past experience and this estimate approximates the amount of work which any good man should do on a good machine.

As time goes on, the foreman compares the estimated time with the time actually taken and his estimates become more accurate. When he has made use of all the knowledge he has as to the best and quickest way to perform each job, he asks the superintendent for expert assistance in developing still better methods.

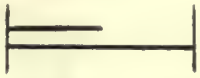
Drawing the Man Record Chart

In keeping a Man Record Chart the foreman uses a sheet which is ruled according to the working hours of his shop and is similar to the one used for the Machine Record Chart shown in Fig. 6 of the first article. On the left side of this sheet he lists the men in his control arranged in groups under his sub-foremen, if he has any. At the top of the sheet he leaves a line for the total of the department.

On the chart the foreman indicates by a line drawn through the daily space how the work done by each man compares with his estimates. The space represents the amount of work the foreman believes should be done; the light line indicates what was done. For instance, an operator has done 150 pieces of work in a day whereas the foreman believes a good man should do 200. He therefore divides 150 by 200, which gives him 75 per cent, and draws a light line through 75 per cent of the space for that day, thus:

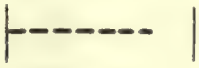


Expressing this in a different way, the space represents the time actually taken to do a certain amount of work while the light line shows how much time it could reasonably be expected to take. For instance: a workman has taken 8 hr. to do work which the foreman had expected him to do in 4 hr. He therefore divides 4 by 8 and draws a light line through 50 per cent of the space. Another workman has done in 8 hr. what the foreman expected would require 12 hr. of a good man's time. He therefore divides 12 by 8 and draws a light line through 150 per cent of the day's space, i.e., one line all the way across and another half way across, thus:



Light lines drawn through a second day's space are offset from those of the first day so that they will not appear to be continuations, thus:

If the foreman has not estimated the time any work should take, he draws a broken line through an amount of space representing the time actually spent on that work, thus:



The portion of the daily space through which no line is drawn shows how much the operator has fallen behind in the work expected of him, and the letter at the beginning of the space indicates the reason, thus:

The reasons which occur most frequently are listed in the key to the Man Record Chart (Fig. 10) together with the method of determining which of several reasons should be used. At the end of the week a heavy cumulative line is drawn to show the weekly total of each operator, the heavy line always being equal in length to the sum of the light lines. To get the totals of the various groups and of the whole department, the hours represented by the cumulative lines of the individual workmen are added and divided by the number of men. A line about 1/8 in. wide is used for a group total and one 1/6 in. wide for a department total.

Acting on the Chart

The foreman watches the first line of his chart because it shows him how his department as a whole is living up to his idea of what it should do. If he is not satisfied, he glances over the various group totals to see which group or sub-foreman has fallen farthest behind. He then looks over the lines for the individuals responsible to that sub-foreman and studies the detailed reasons why they could not do a full week's work. This enables him to concentrate his attention on the individuals most in need of help and on those hindrances to production which occur most frequently.

The foreman is usually surprised to see that the fail-

ure of the operator to do the work within the estimated time is more often his fault than that of the workman. He learns how much of the time of his men is wasted because of the improper sharpening of tools, defects in materials which should have been caught by the inspectors, the unsatisfactory condition of machines and the lack of proper instructions on new work. He understands better than ever before why the costs of so many jobs exceed his estimates.

The discovery that possibly nine-tenths of the obstacles which prevent a man from doing a day's work are the fault of the management should not surprise the foreman, for management has assumed the responsibility of securing materials, machines and tools, of keeping those machines and tools in proper condition for work, of bringing material to the operators when it is needed, of giving workmen proper instructions, and of doing whatever else is necessary to leave the workman free to do the kind of work for which he is best fitted and which gives him the largest return.

Those problems which are the most complicated in modern manufacturing are put up to the management. The task of the workman is easier, that is, to make use of the knowledge and follow the instructions given him by the management.

The foreman knows that he is judged to a great extent by his ability to run his department so that his men can do a fair day's work and that it is to his ad-

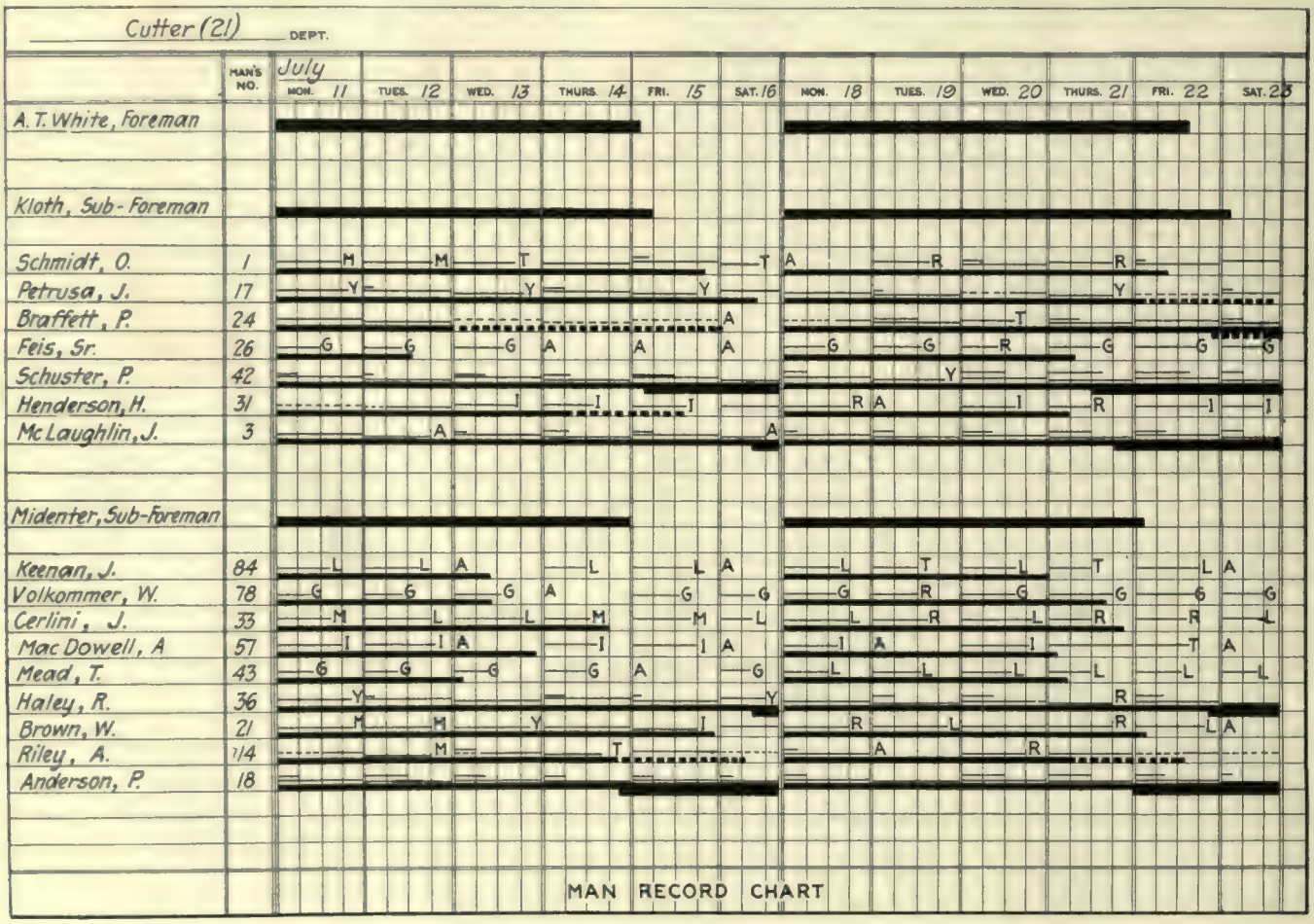


FIG. 10 A GANTT MAN RECORD CHART

LEGEND

Width of daily space represents amount of work that should have been done in a day.

Amount of work actually done in a day.

Time taken on work on which no estimate is available.

Weekly total of operator. Solid line for estimated work; broken line for time spent on work not estimated.

Weekly total for group of operators.

Weekly total for department.

The portion of the daily space through which no line is drawn shows how much the man has fallen behind what was expected of him.

REASONS FOR FALLING BEHIND

A—Absent
G—Green operator
I—Lack of instructions
L—Slow operator
M—Material troubles
R—Repairs needed
T—Tool troubles
V—Holiday
Y—Smaller lot than estimate is based on.

When there is more than one reason for failure to do the work in estimated time, the reason entered on chart is determined by asking questions in the following order:

R—Was the machine in good condition?
T—Were the tools and fixtures in good condition?
I—Was the operator given proper instructions and sufficient information?
M—Was trouble experienced with material?
G—Was the operator too green to do the job?
L—Was the operator too slow?
Y—Was the lot smaller than estimate is based on?

vantage to help those who keep the average down. He realizes that the idler and the slow worker are more in need of help than the good worker. From the Man Record Charts the foreman secures such information about individual production as will enable him to instruct those men who are most in need of help.

When he has removed most of the obstacles over which the management has control, the foreman shows these charts to his workmen with the idea of developing their ambition and a spirit of rivalry. The charts are so simple that they can be understood by anyone—even by a foreigner who cannot read the language in which they are written. When his line and those of his companions are pointed out to him, he can see how his work compares with that of the others.

A foreman soon learns that the long production lines of the two or three men who are head and shoulders above the others seem to have little effect on the average workman, but that he is very strongly influenced by the lines of the men he considers his equals. He hates to be beaten by an equal and will do all he can to keep up with him. But above all he appreciates the opportunity to watch *his own* progress from day to day.

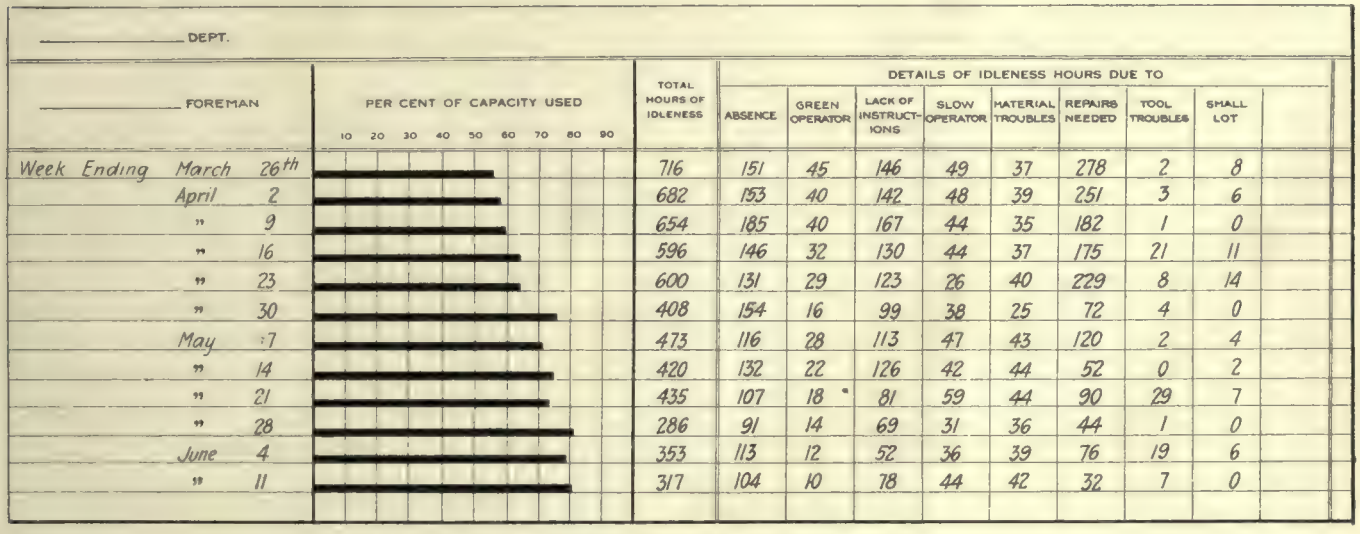
There are some workmen, however, who cannot measure up to the average and do not respond to the foreman's effort to arouse their ambition. These are the men he studies most carefully. Even without records these men know whether they are better or worse than those around them, and they resent the introduction of methods which make this fact evident to the foreman and the other workmen. Those who have in the past tried to cover up their low production by attempting to stand in with the foreman and can no longer do so, are opposed to these records and do all they can to undermine their usefulness.

Experience has taught the foreman that men who feel their inferiority are very apt to do everything possible to distract the attention of others from that inferiority. This frequently shows itself in flagrant breaches of shop discipline or in creating discontent in the minds of others. When the foreman studies these men with short lines on the chart, he realizes that this type is usually the backbone of strikes and discord in his department. Their consciousness of inferiority and their discontent are continually smoldering and are easily fanned into flame by some fancied grievance, some real injustice, or some capable agitator. The foreman who wants fewer labor troubles in the future realizes that he must solve the problem of what to do with those men who are below the average—whose lines are short on the chart. Shall he drop them from his pay-roll and ask the employment department to hire others to fill their places? He knows that the available supply of good workmen in most cities, except in times of business depression, is inadequate and that those hired will probably be just as poor as those discharged.

The foreman who is looking into the future does not discharge these men; he trains them to do at least one job well. He tries them out on various kinds of work until some job is found on which they can do better work than on others. On this job a man is given special instruction; so that no matter how long it takes to bring him up to the average, there are always sufficient instructors to help him.

This method of handling short-line men appeals to the foreman's sense of fair play, for he is giving these men for once in their lives a real chance to make good. When men who formerly had short lines get to the point where they are turning out a full day's work week after week, they have almost invariably forgotten their discontent and some of them even show an awakening ambition. A man who for years has considered himself a "wage slave" gains a self-confidence and a self-control which make a free man of him. He shows possibilities which were quite unsuspected until he mastered his job.

Man Record Charts are invariably welcomed by good workmen, if the charts are used to help the workmen rather than to drive them. These charts also provide the foreman with a fairly accurate basis for regulating the wages of his operators in accordance with their production. Favoritism and special privilege are done away with and promotions are based on facts rather than on impressions.



_____ DEPT.

_____ FOREMAN

PER CENT OF CAPACITY USED 10 20 30 40 50 60 70 80 90

	TOTAL HOURS OF IDLENESS	DETAILS OF IDLENESS HOURS DUE TO							
		ABSENCE	GREEN OPERATOR	LACK OF INSTRUCTIONS	SLOW OPERATOR	MATERIAL TROUBLES	REPAIRS NEEDED	TOOL TROUBLES	SMALL LOT
Week Ending March 26th	716	151	45	146	49	37	278	2	8
April 2	682	153	40	142	48	39	251	3	6
" 9	654	185	40	167	44	35	182	1	0
" 16	596	146	32	130	44	37	175	21	11
" 23	600	131	29	123	26	40	229	8	14
" 30	408	154	16	99	38	25	72	4	0
May 7	473	116	28	113	47	43	120	2	4
" 14	420	132	22	126	42	44	52	0	2
" 21	435	107	18	81	59	44	90	29	7
" 28	286	91	14	69	31	36	44	1	0
June 4	353	113	12	52	36	39	76	19	6
" 11	317	104	10	78	44	42	32	7	0

FIG. 11 A MAN RECORD SUMMARY CHART

One day as he walked through a plant of one of his clients, Gantt stopped to talk to an operator and asked him what he thought of the Man Record Charts. The operator replied, "I always knew I was the best man in the shop, but no one would believe it. Now everyone knows it." For the first time in his experience this man had secured proper credit for the work he did and it was natural for him to welcome these records.

Careful consideration is given by the foreman to a workman's suggestions for improvements which will increase his output, because it is to the foreman's in-

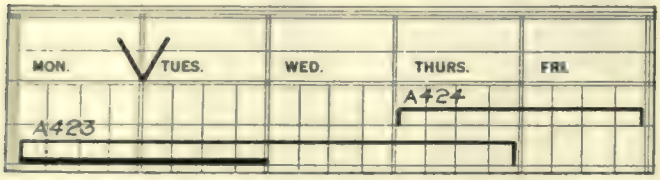


FIG. 12 HOW WORK AHEAD OF SCHEDULE IS SHOWN BY THE GANTT LAYOUT CHART

terest to do so, since an increase in output will lengthen his production line as well as the operator's.

The workman sees the man whose line is longest, whose production is greatest, appointed to the position of sub-foreman when there is a vacancy. He sees the sub-foreman whose group line is longest become a foreman. As he watches these changes take place throughout the organization and positions of authority given to men who "know what to do and how to do it," he sees opening up before him possibilities of advancement limited only by his ability and his interest.

In order to get the help of the superintendent in removing delays over which he himself has no control, the foreman sends copies of his Man Record Charts to the superintendent each week. With them he sends a Man Record Summary (Fig. 11) showing the total line of the department for each week. This summary enables the superintendent to see very clearly any tendencies toward lower production and to take whatever steps may be necessary to guide his shop policy.

When the estimates of all the departments are made on the same basis, the superintendent is also enabled to compare the ability of his foremen to get work done. Since production is the aim of the entire organization and these charts point out the men who are successful in getting production, the superintendent or the manager will be able to build up an organization of men who have proved their ability to produce.

THE GANTT LAYOUT CHART

Idleness of men and machines is usually the greatest waste in a manufacturing plant and yet when the reasons for idleness, such as lack of help, material, orders, tools, etc., are presented to the management in such detail as to fix responsibility, it is possible to take definite steps to prevent its continuance. This is done by planning work sufficiently far in advance to advise each individual concerned what he is to do and when he is to do it. In some plants where a uniform product is manufactured, this is not a difficult matter. If, for instance, 100 machines are being made each week, every foreman or workman knows that he is to turn out enough parts to make 100 machines. The planning in such a case is very simple and can sometimes be done without any written record. There are very few plants, however, which produce only one article—usually a department has to turn out a great many different parts to be used in the assembling of a varied product. It is also probable that these parts are worked on in other departments. It therefore becomes necessary for the foreman to plan carefully the work to be done on each machine in his department and also for the superintendent or manager to plan the work to be done in all the departments of the plant.

The Gantt Layout Chart is used in working out a plan that will get the orders in hand done when they are wanted and make the best possible use of the available men and machines. No method of doing this can be satisfactory unless it emphasizes above everything else when jobs are to be begun, by whom they are to be done, and how long they will take.

IN A MACHINE SHOP

In planning work in a machine shop a sheet is used which is ruled to represent the working hours of the plant, the ruling depending upon the average length of jobs. If they extend over several weeks, the wide columns represent weeks and the narrow ones days, if

FIG. 13 HOW WORK BEHIND SCHEDULE IS SHOWN BY THE GANTT LAYOUT CHART

they run less than a week, the wide columns represent days and the narrow ones hours, and if they last less than a day, the wide columns represent hours and the narrow ones fractions of hours.

All the machines or work-benches in a department or shop are listed on the left side of this sheet. When an order is received a list of the operations through which the material is to go is looked up if it is not already shown on the order. On the Layout Chart opposite the machine which is to do the first operation the order is laid out.

An angle opening to the right, as shown by the legend to the Layout Chart (Fig. 14), indicates when the job is to be started; an angle opening to the left when the job is scheduled to be completed; and a light line connecting the angles the total time scheduled for the order.

The machine on which the next operation is to be done is looked up on the chart to see when it will be ready for additional work. The order is then assigned to this machine and the angles and the light line are drawn. This procedure is followed in laying out all the operations on that order and is continued until all the orders are laid out.

In assigning work to machines, it is necessary to know what progress has been made on the work already

assigned. Accordingly, as daily reports are received showing the amount of work done, a heavy line is drawn under the light line, as clearly shown in Figs. 12, 13, 14, and 15.

If the work is exactly on schedule, the end of the heavy line will be directly under the proper date and hour. If the work is behind or ahead of schedule, the end of the heavy line will be behind or ahead of the date. In assigning a new order to a machine, if the work is *ahead of schedule,* the new order is placed over the old one, and the date of beginning is placed in advance of the date of completion of the old order, as shown by Fig. 12. The "V" indicates the date. The work is one day ahead of schedule, and conditions in the shop indicate that it will be one day late finishing. The new order "A424," is therefore laid out to be started Thursday morning.

If the work is *behind schedule,* there is no advantage in planning to begin the new order until the old one is complete. Therefore, sufficient time must be set aside to make up for past delays before the new work can be begun. This is indicated on the chart by connecting the angles by crossed lines, as in Fig. 13. On the date shown by the "V" the work was one day behind schedule. Before assigning order "A426," one day is allowed to make up for the delay and is indicated by crossed lines. Above the light lines are written whatever numbers and quantities may be necessary to identify the orders.

When work stops on any order a jog is placed under the line with an initial to indicate the reason. The more common ones being, as shown by Fig. 14, repairs, lack of help, material, power, or tools.

This graphic layout makes it possible to group orders and distribute them over the available machines in a much more intelligent manner than by the hit-or-miss method of deciding what the next job will be whenever a machine runs out of work. When a machine breaks down, it is easy to transfer work from it to other machines without disturbing the proper sequence of work. When it is desirable to rush a certain order through ahead of other work, the use of a Layout Chart makes

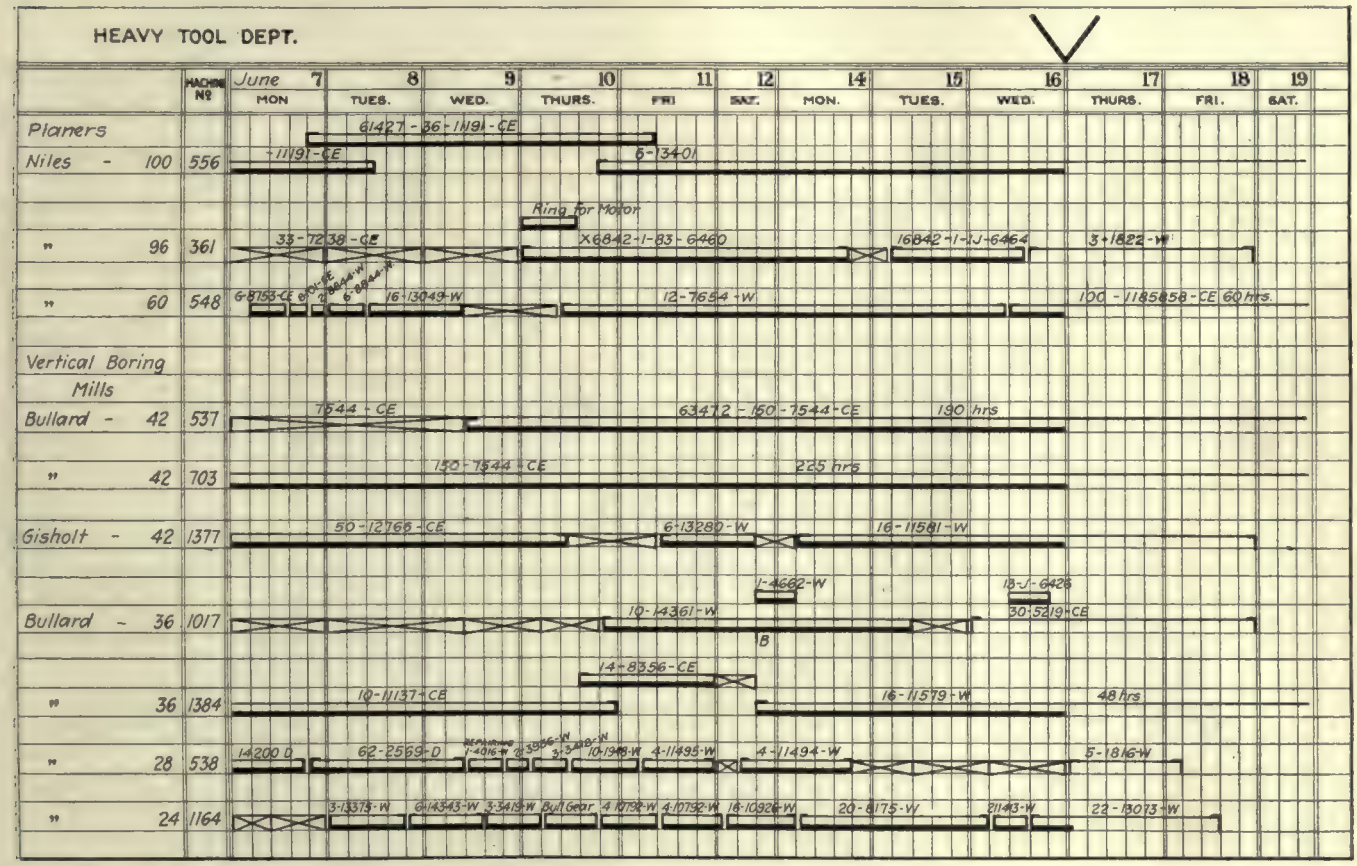

HEAVY TOOL DEPT.
June 7 8 9 10 11 12 14 15 16 17 18 19
MON TUES. WED. THURS. FRI SAT. MON. TUES. WED. THURS. FRI. SAT.
Planers
Niles - 100 556
" 96 361
" 60 548
Vertical Boring Mills
Bullard - 42 537
" 42 703
Gisholt - 42 1377
Bullard - 36 1017
" 36 1384
" 28 538
" 24 1164
Ring for Motor
150 - 7544 - CE
225 hrs
190 hrs
48 hrs

FIG. 14 A GANTT LAYOUT CHART FOR A MACHINE SHOP

LEGEND

- Date job is scheduled to start.
- Date job is scheduled to be completed.
- Total time scheduled for order.
- Work done.
- Time required to make up for past delays. Figures above lines indicate order numbers.
- Indicates that chart was reproduced Wednesday night and shows how the work stood at that time.

REASONS FOR STOPPING WORK

B—Break-up
H—Lack of help
M—Lack of material
P—Lack of power
R—Repairs
T—Lack of tools

it possible to do so with maximum speed, because the chart visualizes not only the time required to do the rush order but also that needed to get the other work out of its way. There is an added advantage in that the chart shows clearly how this rush order interferes with the work already in the plant and makes it possible to revise any promises which may be broken.

In a machine shop or textile plant work is planned by machines; in a foundry by floors, benches or machines, and in a pattern shop or die sinking department by men. The chart for the heavy tool department (Fig. 14) illustrates the planning of work for machine tools on which only one job can be done at one time. On

It will be observed that the heavy lines on the Gantt Layout Chart show how much work has been done and how far it is behind or ahead of the schedule, but it does not show just when the work was done. If an attempt were made to present that information also, the chart would become so complicated that it would not be clear. The purpose of the Layout Chart is to plan work; it is necessary to show how the work stands when a new job is assigned, but it is not necessary to know in detail what has happened in the past.

The same type of Layout Chart is used by the various foremen and by the central planning office, except that the foremen plan only one day in advance, while the

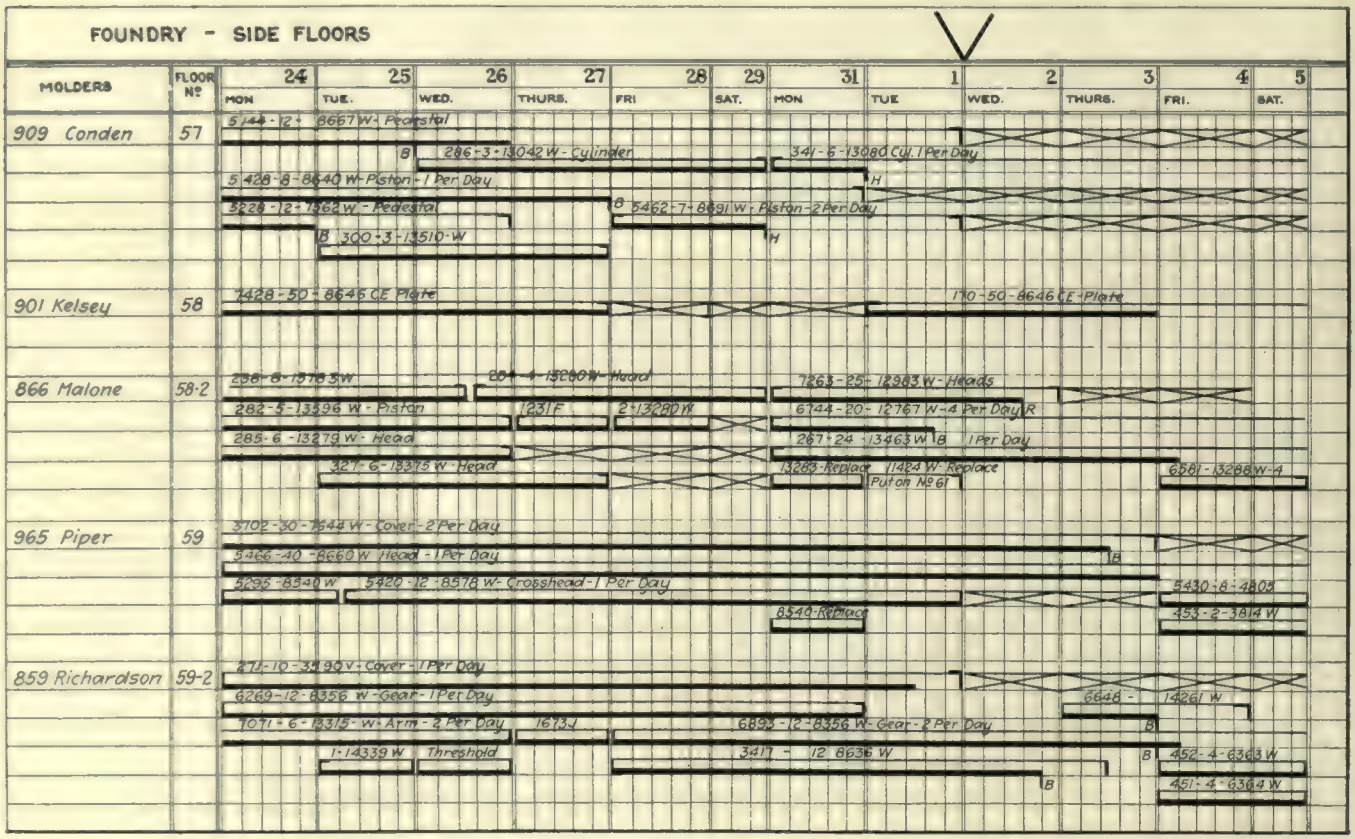


FIG. 15 A GANTT LAYOUT CHART FOR A FOUNDRY

drills with more than one spindle, on grinders with two heads, and other machines, it is possible to run more than one job at a time. On a molding floor in a foundry, for instance, the molder frequently works on several jobs in a day, the number depending on the importance of the work, quantity of patterns for each order, time necessary to put up each mold, and size of the floor.

The Layout Chart for a foundry (Fig. 15) shows how a variety of orders is planned for each man. Molder No. 909, Condon, is behind schedule, which is indicated by the fact that the heavy lines representing work done do not run to Tuesday night, when the chart was reproduced, as shown by the "V." The reason he is behind is made clear by the "B's" showing that he had had to break up on some orders and start new ones, and by the "H's" which indicate that he was absent for a day. The last molder on the sheet, No. 859, Richardson, is ahead of schedule on all but one of his orders.

planning office lays out ahead of time all the work for the plant.

The Gantt Layout Chart is much more satisfactory than a layout board because it is more easily handled. It does not require any wall space, but can be used on a desk or table, kept in a drawer and carried around easily. Work is laid out in pencil and no expensive equipment is needed.

The Gantt Layout Chart helps to get work done because it makes clear who is to do any piece of work, when it is to be done, and how long it will take. It can be successfully made out only by one who knows what is to be done, how it can be done, and how long it will take. Instructions based on this chart will, therefore, create confidence in the mind of the one who is to do the work. It is possible through this chart to assign definite tasks—and the more definite the task the easier it is to get it done.

Moving Parts From Operation to Operation

Four Methods Are Available: Moving by Trucks, Rolling Down Chutes, Sliding on Gravity Conveyors, Handling by Power Conveyors

By J. M. MACRAE

Chief Engineer, Cadillac Tool Company

FAR too often manufacturing machinery is designed or selected and then laid out and installed with total disregard of convenience and economy in handling the parts to the machine or the material to be operated upon. This failure in planning is more often seen in plants manufacturing in successive operations than in those plants using continuous processes, and particularly in plants constructed and equipped longer than a decade ago. The newer automobile building plants show the results of engineering effort and skill in securing maximum economy in transporting and moving of work in process.

In any shop department it is not difficult to set up the machines in the proper sequence of operations, but if at the same time no thought is given to the method of transporting, loading, and unloading the parts, it may be found that the amount of time lost in handling, that is, in "juggling" the parts around, turning them over, and locating them from different faces, is in the aggregate a tremendous waste and expense.

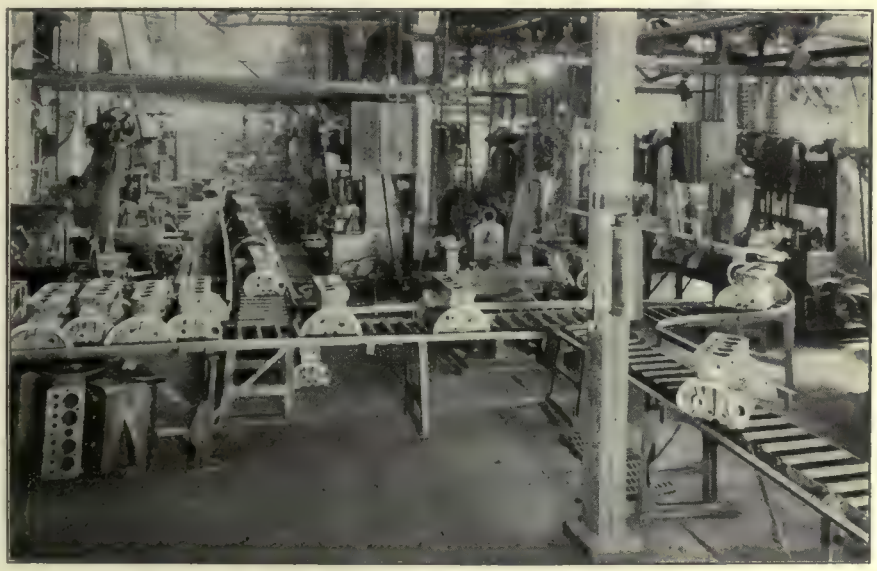


FIG. 1 GRAVITY CONVEYOR TRANSPORTING CYLINDER BLOCS

Every machine used in finishing these blocs is designed to receive the part in the position shown on the conveyor. Thus the blocs pass through an entire department without a change in position.

To determine the most satisfactory method of transporting and handling parts in process the manufacturer must first of all make a study of the part itself. By considering its size and shape and taking into consideration the number or quantity to be transported, one of the following methods may be selected for economical handling:

1. Placed or arranged in boxes or in racks and moved by hand or by truck.
2. Rolled along an inclined plane or down a chute.
3. Slid on a gravity conveyor.
4. Lifted or moved on a power conveyor.

The first method has been used as long as there has been industry and in plants making all kinds of products. In the machine-building industry, from which the illustrations in this article are drawn,[1] it is generally used for small parts such as gears, piston pins, bushings, shafts, arms, levers, and the like. It is in no sense a continuous system, however, and therefore either requires the services of men other than the machin operators, or entails idleness of machines when the operator moves material to and from the machine upon which he is working. The product of the operator is not physically evident at any time. He is not impelled to take and maintain a definite pace of production. This is in contrast to the pace he is forced to maintain when work is brought to him and taken away by means of a continuous transporting system. When such pace control is absent production depends entirely upon the will and disposition of the operator. He may work slowly or rapidly as he chooses and parts may pile up around his machine, occupying valuable floor space in case the men who move material fail to perform their duties. This "cluttering up" often interferes with other machine operators, clogs the aisle of the factory through which the material must be trucked, and in connection with certain operations "messes" the floor with oil or cuttings.

In general contrast to this method, or lack of method, are the three others mentioned in a preceding paragraph and illustrated in the accompanying views.

The superiority of the second method—rolling on an inclined plane or along a chute—lies in the elimination

[1] The illustrations are all from the Fordson plant at Dearborn, Mich.

of most of the disadvantages of hand trucking. It is convenient for small parts which may, however, be dissimilar in kind, size, shape, and weight. Typical parts for whose handling this method is economical are pistons, piston rings, gear blanks, fly wheels, and the like. These are rolled along the inclined plane or chute until in a position within easy reach of the operator.

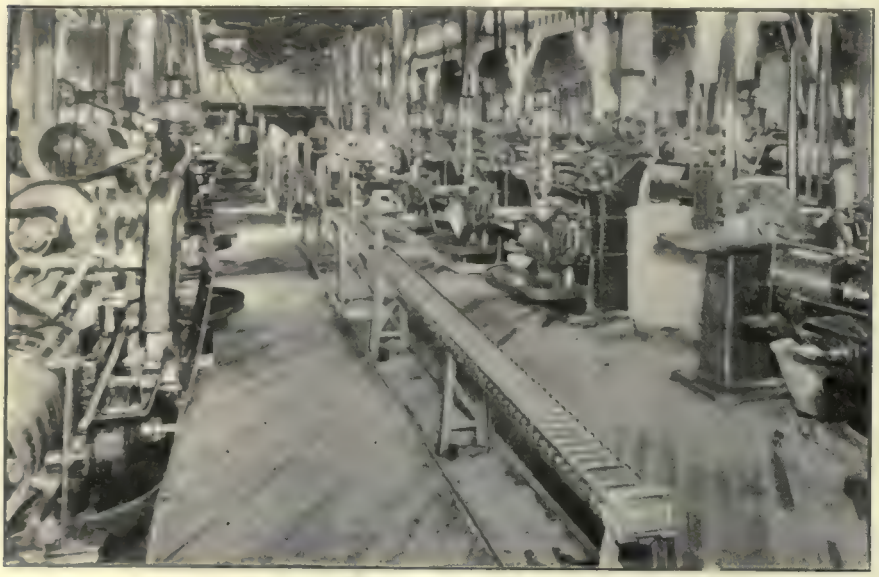


FIG. 2 GRAVITY CONVEYOR FOR TRANSPORTING GEARS

The gears are transported from one operation to another with the shaft upright. Note that the aisles are free from work, that the floors are clean, and that stock does not accumulate around the machines.

The first cost and maintenance cost of a series of conveyors of this type are very small, and the method and installation can be recommended wherever the character of the part and a sufficient quantity will permit of their use.

When for some reason the inclined plane or chute cannot be used, the third method, that is, by gravity conveyors, is next in preference because of its advantages in first cost and up-keep charges. For the successful use of a gravity conveyor, the parts to be handled must lie flat on one surface, and each must be of sufficient weight to acquire momentum when sliding along the rollers.

This type of conveyor lends itself to many interesting applications. For example, an engine crankshaft may be made to travel in a vertical position on the flywheel flange on a system of two such conveyors arranged at right angles to one another. In this position the crankshaft takes up a minimum amount of horizontal space and the machined surfaces are not liable to injury or damage.

FIG. 3 ANOTHER TYPE OF GRAVITY CONVEYOR

The rollers are shaped to convey shafting or round stock.

The fourth method mentioned for moving parts from operation to operation or machine to machine—by power conveyors—is only applicable when the two preceding methods are impossible in installation or impracticable in use. Power conveyors are more expensive to instal and to operate than either of the other systems, but on the other hand the power conveyor is the most satisfactory type for transporting finished products from the various factory department to the assembling room. In this instance parts of all shapes and sizes must be accommodated and handled, and the distances to be covered in moving from manufacturing departments to assembling departments are ordinarily far too great for the application of a gravity conveyor or a chute.

In selecting the transportation system to be used within a department and in laying out and arranging the machinery to keep everything in perfect balance (that is, to time each operation equally), the manufacturer is in reality building up a series of units. A single department, including its conveyors, machines, and operators, may be considered as one complete machine producing the required number of parts at the maximum efficiency. If it were possible for the executive to arrange his entire factory on this basis, to increase production would simply require an increase in the number of these units.

But to secure such a result requires a careful study involving a considerable amount of time to search through each individual phase of the conveyor problem. The proper method of handling a single part, say the cylinder bloc of an automobile engine, can only be determined by careful analysis. The same holds true for every other part. The wiser course is to plan the method of conveying the parts from machine to ma-

chine for each operation. Such planning will secure the most desirable result from every point of view, for often greater economies can be obtained in simplifying and improving the transporting and handling than in bettering the methods of performing the operations.

Taking the cylinder bloc as a further example, consider the advantage of having it travel through from operation to operation and machine to machine in one position only. To secure this advantage every fixture must be designed to permit location from the same point. The normal position must permit of transporting from one machine to another by a simple gravity

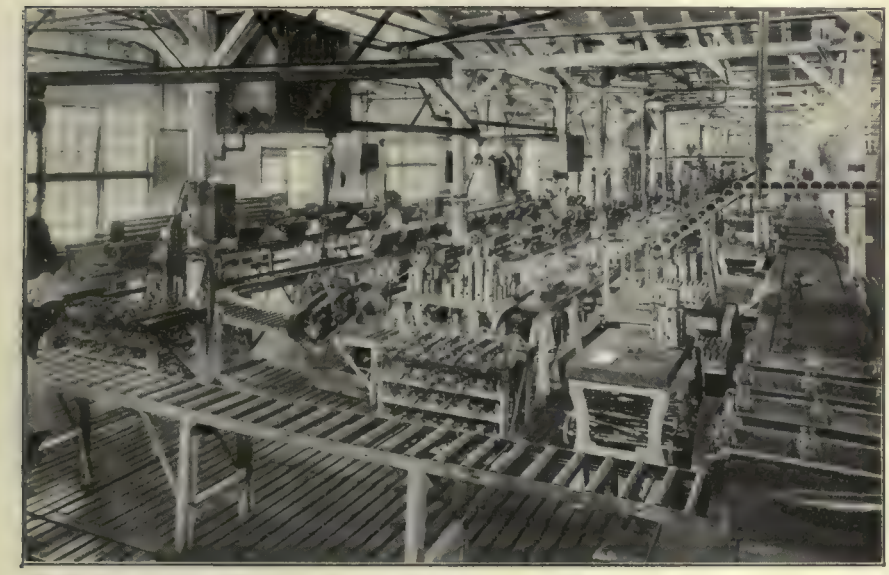


FIG. 4 A POWER CONVEROR OPERATING BETWEEN MACHINING DEPARTMENTS AND THE ASSEMBLING ROOM

This conveyor is shown in the right foreground and upon it are a variety of parts. It is in reality a wide, moving platform. This view also shows an inclined plane or chute located at the extreme right filled with pistons and crossing the power conveyor at a high level.

conveyor. Securing and maintaining such a position from start to finish of the machining cycle means that not a second of time is lost in turning the piece over or other unnecessary handling.

The manufacturer who selects his machinery, plans his conveying apparatus, and lays out his shop departments with these points in mind, will have an efficient shop even though his original investment in machines and equipment may be high. He will secure the advantages of having his work run along smoothly, of having it conveyed automatically from operation to operation, and so on through the shop, of eliminating the confusion resulting from the use of hand-trucks and tote-boxes, moving in an undirected and unorganized way, and of requiring fewer men to secure the volume of production.

Throughout all such planning, the thought of economy must be uppermost. No one system is of universal application. With a small volume of production, the simplest methods will probably be the most effective, but under conditions of large-scale production, one may profitably design and instal elaborate equipment and thereby secure great advantages and economies, not only in regard to labor costs but also in controlling the orderly progress of the work.

Safety devices and measures *614.8*

How We Made a Record for Safety

By C. B. BARTLETT

Production Engineer, Gender, Paeschke & Frey Company

MANY large manufacturers have proved that accidents in industry can be materially reduced by the work of a thorough-going safety organization. But the record for no accidents during a period of six weeks made by the company with which the writer is connected is the first so far as he knows to be established in a plant having for its equipment a large percentage of punching, stamping, and forming presses, such as are required in the manufacture of deep-drawn and pressed sheet-metal parts. These machines are classified by insurance rating bureaus as extreme hazards.

The record referred to is a part of the accident statistics shown in Table 1. In the six months' period, January to June, 1920, the number of 10-hr. days lost due to accidents totaled 3,104 during 1,543,940 hr. of work. In the identical period of 1921 the number of 10-hr. days lost was reduced to 596 in 802,330 hr. worked. The time lost during the first period was caused by 203 accidents, while in the second period there were but 88 accidents. The six weeks' period with no accidents causing lost time was from June 15 to August 1, 1921. Between July 18, and August 1, there were no accident cases in the hospital causing a loss of time.

THE METHOD BEHIND THIS RECORD

During the period of war the accident total in American industry increased tremendously and gave a new impetus to the safety movement. For the year 1919 the Wisconsin Industrial Commission stated that 97,980 working days had been lost by the factories of that state, due to accidents. In attacking this problem in our own plant with a determination to reduce our share of this total, we adopted a method which is significant and worthy of consideration because it reaches the very heart of the organization for effective production. It was adopted only after six months of careful investigation and consideration of advice based upon the accumulated experience of some of the best American safety engineers. It is founded upon the conviction that the workmen themselves must be reached if accidents are to be reduced, and that the only way in which this can be done consistently is through and by foremen.

From this belief comes a method that is unique. As safe production is a function of the production department, and therefore a responsibility of management,

the works manager was made chairman of the general safety committee and the production engineer was made the committee's secretary in active charge of all safety work. The foremen were made safety inspectors, each for his own department and each directly responsible for his own results.

"It is recognized that the foremen do such portions of the work as the management insists upon. If the management is well balanced the work of the department heads will be well balanced. If the management is out of balance—if they insist upon sales or production at the expense of safe production—a foreman will reflect that attitude as in a mirror."

General Results of This Method

During the past 18 months it has been proved again that results can be obtained in a manufacturing organization in exact proportion to the honest desire of the heads of that organization to accomplish the end sought for. The general orders establishing our new method and starting the organization on a full working schedule were issued as of July 1, 1920. The number of accidents was reduced immediately. During the summer of 1920 we were occupied with more unsolved production problems than in any like period of our manufacturing history. The factory capacity was over-sold, labor turnover everywhere was staggering in its amount, no additional supply of labor could be discovered, and individual efficiency was at its lowest ebb. Taken altogether, the nerves of the factory personnel were on edge and seemingly ready to break under the excessive strain.

But under such conditions we reduced the rate for machine accidents 77.5 per cent during a 90-day run from June 12, to September 11, 1920. During this time we had but two machine accidents in 50 departments employing 1,350 workers on more than 700 sheet metal punching, stamping, and forming machines.

Of unusual significance was the clear proof during this same period that safe production and maximum production are identical. In spite of the handicaps of those weeks, the man-hour output based on a scale which eliminates the appreciation of both material and labor was the highest in the history of the company. Yet not a cent had been spent on personnel for a safety organization. But everyone, from the president and secretary to the last straw boss, had convinced himself that safe work yielded quantities of good work.

More Managerial Results

The conditions brought about by the end of the business boom towards the close of 1920, again demonstrated that the foremen do what the management insists must be done. Previous results showed that the foremen could do anything which they tried hard enough to do, and so the safety of the plant was placed in their hands and made their responsibility. It was shown to them that safety depends upon the efforts of the individual and that the quality of production must be carried as high as, if not higher than, before-the-war standards. Emphasis was placed upon economy of operation. Machines and tools were thoroughly repaired, alterations were made and attachments added to increase the safety of operations. Here and there punches and dies were designed with feeds so devised that there was no danger of human fingers coming in contact with the tools when in operation. Machines, presses, and tools that "cannot be guarded" were nevertheless guarded, and above all none of these machines, tools, and devices were O K'd for production until their output equaled or excelled the former production rates.

During all this time accidents were steadily reduced in number until in February the low rate of 0.264 of a day's loss due to accidents for every 1,000 hr. worked was established for a full month's period. In the latter part of March new proof came that the foremen could control accidents. Our record slipped suddenly in the last week of the month, and on Monday, April 4, every superintendent and foreman was spoken to personally and shown where and how accidents were increasing. During that week no accident occurred.

TABLE I. NUMBER OF DAYS LOST DUE TO ACCIDENTS

Cause of Accident	Period Jan.-June 1920	Period July-Dec. 1920	Period Jan.-June 1921
Press accidents	815	348	132
Partial permanent disability	1,132	604	16
Eyes	81	63	69
Infection	246	77	69
Cuts	123	58	33
Bruises and falls	347	232	121
Strains	101	52	130
Acid irritation	72	118	.....
Burns	97	56	18
Miscellaneous	90	59	8
Exposure, hours	1,543,940	1,444,570	802,330
Severity	2.00	1.15	0.69

As the end of the first year of this accident prevention and safety work approached a "no accident month" was suggested. The month selected, however, did not start off satisfactorily, and small accidents continued to occur. But the effort to reach the objective was continued, and by June 15 results began to show. For six weeks from that time there was no accident of a severity sufficient to cause the loss of one day's time. This gave an opportunity to clear up all the cases in the hospital, and from July 18, to August 1, the hospital records show a blank for accident cases.

We believe that the key to these results lies in the fact that the management has given the foremen an opportunity, and that the safe operation of a factory is a vital obligation of the manufacturing organization. The foremen in turn co-operate to reach the workmen, thus making the function of safe production one of the responsibilities of the production department as a whole. They were thus able to combine and make identical safe production and maximum production, the latter being in one aspect to by-product of the former.

A Year of the Kansas Industrial Court

By P. F. WALKER

Dean, School of Engineering, University of Kansas

THE much discussed Industrial Court of Kansas took material form on February 2, 1920, when the court was organized, with W. L. Huggins, C. M. Reed, and G. H. Wark sitting as judges. Some time was spent necessarily in organizing and in reshaping the public utilities end of the duties that had been assigned to the new court by the enacting legislative measure, so that but little more than one full year of active work has been completed. What this period of service has brought forth in the way of actual accomplishment, and how the idea set forth in the law has weathered the storms of court experience and of a year and a half of discussion, sometimes excitable in tone, on the part of the people of the state, are questions that are asked frequently. It is the present purpose to answer these questions rather than to debate the merits of the system of settling industrial disputes here being given its experimental workout.

In justice to the court, it should be explained that for the first year of its legal existence there were combined with the industrial relations duties and functions all of the duties of the public utilities commission. The economically inclined legislature had thought it possible for one commission or court to perform in both lines. As a result, the court was nearly swamped with utilities cases during the latter part of 1920, when the telephone companies in particular were in their mad rush to secure higher rates while the getting was good under high valuation conditions. The result, of course, was that the court had no time in which to attend to certain functions which are of prime importance in the system, namely the right and duty to conduct investigations of conditions on their own initiative, to the end that the interests of the general public in industry may be protected. This defect, however, was remedied by the legislative assembly in regular session during the first months of 1921, by restoring the separate utilities commission and joining the Court of Industrial Relations with the Department of Labor and Industry.

The Main Provisions of the Law

For the benefit of those readers who may not be familiar with the main provisions of the law the following note and quotations are given:

> The operation of the following named and indicated employments, industries, public utilities and common carriers is hereby determined and declared to be affected with a public interest, and therefore subject to supervision by the state as herein provided for the purpose of preserving the public peace, protecting the public health, preventing industrial strife, disorder, and waste, and securing regular and orderly conduct of the business directly affecting the living conditions of the people of the state and in the promotion of the general welfare, to wit.—Sec. 3.

The list of employments, stated in brief, includes those engaged in the manufacture of food products, clothing, and wearing apparel in common use, the mining of fuels used in domestic or industrial enterprises, the transportation of the above-named commodities, and the public utilities. As before stated, the court now deals only with employment problems of public utilities, no longer sitting as a commission to set rates for such utilities.

> In case of a controversy arising between employers and workers, or between groups or crafts of workers, engaged in any of said industries, employments, public utilities, or common carriers, if it shall appear to said Court of Industrial Relations that said controversy may endanger the continuity or efficiency of service of any of said industries, employments, public utilities or common carriers, or affect the production or transportation of the necessaries of life affected or produced by said industries or employments, or produce industrial strife, disorder or waste, or endanger the orderly operation of such industries, employments, public utilities or common carriers, and thereby endanger the public peace or threaten the public health, full power, authority and jurisdiction are hereby granted to said Court of Industrial Relations, upon its own initiative, to summon all necessary parties before it and to investigate said controversy, and to make such temporary findings and orders as may be necessary to preserve the public peace and welfare and to preserve and protect the status of the parties, property and public interests involved pending said investigations, and to take evidence and to examine all necessary records, and to investigate conditions surrounding the workers, and to consider the wages paid to labor and the return accruing to capital, and the rights and welfare of the public, and all other matters affecting the conduct of said industries, employments, public utilities or common carriers, and to settle and adjust all such controversies by such findings and orders as provided in this act. It is further made the duty of said Court of Industrial Relations, upon complaint of either party to such controversy, or upon complaint of any ten citizen taxpayers of the community in which such industries, employments, public utilities or common carriers are located, or upon the complaint of the attorney-general of the state of Kansas, if it shall be made to appear to said court that the parties are unable to agree, and that such controversy may endanger the continuity or efficiency of service of any of said industries, employments, public utilities or common carriers, or affect the production or transportation of the necessaries of life affected or produced by said industries or employments, or produce industrial strife, disorder or waste, or endanger the orderly operation of such industries, employments, public utilities or common carriers, and thereby endanger the public peace or threaten the public health, to proceed and investigate and determine said controversy in the same manner as though upon its own initiative. After the conclusion of any such hearing and investigation, and as expeditiously as possible, said Court of Industrial Relations shall make and serve upon all interested parties its findings, stating specifically the terms and conditions upon which said industry, employment, utility or common carrier should be thereafter conducted insofar as the matters determined by said court are concerned.—Sec. 7.

> The Court of Industrial Relations shall order such changes, if any, as are necessary to be made in and about the conduct of said industry, employment, utility or common carrier, in the matters of working and living conditions, hours of labor, rules

and practices, and a reasonable minimum wage, or standard of wages, to conform to the findings of the court in such matters, as provided in this act. . . . Such terms, conditions, rules, practices, wages, or standard of wages, so fixed and determined by said court and stated in said order, shall continue for such reasonable time as may be fixed by said court, or until changed by agreement of the parties with the approval of the court.—Sec. 8.

Power to Enforce Decisions

It is further noted that the Court of Industrial Relations is authorized to bring proceedings in the supreme court of the state to enforce its decisions, any dissatisfied party in a controversy having the same privilege for redress. The right of collective bargaining is expressly allowed and encouraged, with the proviso that there shall be a properly organized group of workers with responsible officials.

Acts declared unlawful are the following: For any employing firm to discharge or discriminate in any way against an employee who has served as a witness or who has in any way been instrumental in bringing any case before the court. Similarly for any combination of persons to attempt reprisals of any sort by boycott or other means against persons or corporations that have invoked the jurisdiction of the court. For any firm engaged in any of the industries here listed to limit or cease operations wilfully for the purpose of limiting production or avoiding the provisions of the act. Also for any individual employee to conspire with others to quit their employment for the purpose of interfering with the conduct of the business; in other words, to strike in the ordinary meaning of that term. Penalties are fixed for individuals and for officials of both employers and employees for violations.

First Twenty Cases Filed by Employees

The cases which have been brought to the court represent various phases of the industrial life of the state. Of the first 20 cases filed by employees which were passed upon by the court, 16 were for the purpose of securing increases in wages. In 13 of these an increase was granted and in 3 the decision was against the increase. The other 4 cases involved only working conditions. One case only has been filed by an employer, that being by a small industry whose business did not allow compliance with labor union rules regarding employment of separate men, as fireman and operating engineer, respectively, without financial loss. This matter was adjusted by mutual agreement when national officers of the union involved were advised of the situation. It may be remarked here that much of the usefulness of the court may be found to consist in bringing about adjustments by the application of common sense in industrial disputes, without actual legal decisions and official orders. Many controversies which seem big and important to disputants lose their massive proportions when brought before a legal body for discussion in the light of the industrial welfare of the people of a state.

Of the more interesting cases, two were public utility matters involving wage scales and rules for their application. One was that of the Topeka Edison Company, the electric service company of the city of Topeka, and the other the Joplin and Pittsburgh Railway Company, an interurban electric railway operating in a busy industrial section. The decisions were in favor of the complaining employees, minimum wage scales were decided upon and ordered into effect by the court, and the decisions were accepted without question by the parties concerned.

In a case brought by the Brotherhood of Stationary Firemen and Oilers against all of the railroads of the state, on which the court decision was in favor of the complainants, the defendent railroads appealed the case in the state courts. A question at issue in this case was that of jurisdiction, it being maintained by the railroads that power lay in the labor board provided for in the United States Transportation Act of 1920, for the settlement of labor disputes. Unfortunately the case was never decided as to jurisdiction. An amicable settlement was made, largely on the basis of the award of the labor board that was handed down soon after the decision by the industrial court. This incident brings to mind the never-ending discussion as to the extent of control over the railroads held by the several states. This particular law and established procedure thereunder will be involved in the uncertainty in the future, although this circumstance need cause no disposition to criticize the law. It is only one of several cases of conflict as the states proceed in their various attempts to adjust their internal affairs.

The Howat Case

Two cases have arisen in which the Court of Industrial Relations has encountered determined and sustained opposition. As a result of these contests, however, the exact status of the court is being determined, so that the opposition may be credited with the rendering of a distinct service.

The most spectacular contest has been that with Alexander Howat, the president of District No. 14 of the United Mine Workers of America. In a legal sense the case has developed in the county and state courts rather than in the industrial court, but the constitutionality of the Industrial Court Law has been the point in controversy. The case was carried to the Supreme Court of Kansas, and on June 11, 1921, a decision was handed down. This decision holds the industrial law to be constitutional in every respect, and ends with the following significant paragraph:

Heretofore the industrial relationship has been tacitly regarded as existing between two members—industrial manager and industrial worker. They have joined whole-heartedly in excluding others. The legislature proceeded on the theory that there is a third member of those industrial relationships which have to do with the production, preparation, and distribution of the necessaries of life—the public. The legislature also proceeded on the theory that the public is not a silent partner. Whenever the dissensions of the other two become flagrant, the third member may see to it the business does not stop. The privilege of industrial managers to organize is not disputed. The privilege of industrial workers to organize is expressly recognized. Collective bargaining between the two organizations is not only encouraged, but is in effect placed on a plane of duty. The rights of society as a whole, however, are dominant over

industry; and the state is under obligation to intervene to compel settlement of differences whenever failure of manager and laborer to agree endangers the public safety or causes general distress. The judgment of the district court is affirmed. All the Justices concurring.

Following this decision of the Supreme Court, Howat was brought to trial in the District Court in Cherokee County and convicted by jury of violating the laws of the state by calling a strike of miners in his district contrary to the provisions and orders of the industrial court law. This conviction and the prison sentence following therefrom bids fair to end a long-drawn-out controversy arising from the opposition of this wing of organized labor to the Court of Industrial Relations. The contest has been embittered by the violent methods of Howat, who is a labor radical and one who has tried to rule by methods of violence and dictation. In spite of his boasted defiance of the court, it is made clear by the following figures that under the provisions of the new law there has been a marked improvement in the coal fields, beneficial to all.

During 1920, the first practically full year of operation after the new law went into effect, 900,000 tons more coal were produced than in 1919, with 500 less men. The number of working days for production of coal in 1920 was over 200, as compared with 141 in 1919. In 1920, 10,500 miners drew in wages $4,000,000 more than did 11,000 miners in 1919. It will be recalled that the general bituminous coal strike lasted over from 1919 into 1920, so that the production figures for both years were affected by that unusual condition. The great benefit in the local field came about from the comparative freedom from the inconsequential but annoyingly frequent strikes that have been the curse of the district over which Howat has presided for many years. These beneficial results came almost unconsciously in spite of the assumed defiance with which the labor leader in his public utterances attempted to make good his cause.

The Wolff Packing Company Case

The second case which has brought the Court of Industrial Relations before the highest tribunal of the state was brought by an employing corporation in the form of an appeal from a decision rendered by the court. Employees of the Wolff Packing Company of Topeka filed complaint on January 19, 1921, representatives of the local union of the Amalgamated Meat Cutters' and Butchers' Workmen of North America being the active complainants. The complaints included matters of failure of the company to renew expiring contracts, the wage scale, and conditions of employment in general. In its decision the court upheld the principle of the open shop as it had before existed in the plant, prescribed certain rules of conduct as regards hours worked, giving notice by the company in event of non-operation of the plant, conditions as to providing of proper facilities for women workers, proper sanitation in the plant, etc., and set a minimum wage scale for the several classes of labor employed. The company refused to abide by the decision of the court, and in addition discharged a workman who had been active in taking the case to the court, this being an act expressly declared as unlawful in the original enabling act passed by the state legislature. According to press notices of the last few days (about July 7, 1921) the Supreme Court of Kansas has again upheld the Court of Industrial Relations in every respect. Information as to the final steps in this case is not yet to be had, but there seems to be no doubt as to the outcome.

Judge Huggins' Opinion

These instances serve to indicate the general line of progress. It is to be remembered that the Court of Industrial Relations of Kansas is a new institution and has had to blaze an entirely new trail in the matter of procedure. Precedents did not exist. Under such conditions the opinions and expressed purposes of the men who have had most to do with the creation and administration of the court are of prime significance. The presiding judge of the new court, Hon. W. L. Huggins, in public addresses has said:

I claim that we cannot in justice take away the workingman's right to strike unless and until we give him a better means of defense. Under present conditions [this was spoken before the passage of the original act] he has no other weapon with which to protect himself and his family. Unfortunately, in matters of industrial disputes and disturbances no such means of defense or redress have, as yet, been presented.

And later, after five months of the active work under the law, he says:

The law does more than this [providing of access to courts free of all cost] for the worker in the essential industries. It has expressly declared that it is necessary for the general welfare that he shall receive a fair wage and have healthful and moral surroundings while engaged in his labor. The Court has already defined a fair wage. It has said that a fair wage is one that will enable the frugal and industrious working man to provide himself and family with all the necessaries and a reasonable share of the comforts of life: . . . Further than this the law extends to unorganized the same opportunity as to organized labor.

Governor Allen's Summary

But in this no one may speak with more definiteness and assurance than the Hon. Henry J. Allen, Governor of Kansas, the originator and active defender of the law, who says:

The Court of Industrial Relations has won four notable victories during the past year. The first is the victory with the public. At the election last fall in every district in which the issue was presented the legislative candidate standing as a supporter of the industrial court law was elected. Even in Mr. Howat's own district this occurred, where the opposing candidate was a man of Howat's own choosing and where the campaign was characterized by the most bitter denunciation of the law.

The second victory lay in the stabilization of the mining industry, as an actual result of the operation of the law in the face of determined efforts to make it of no avail. [Note figures already cited.]

The third victory has been in the Supreme Court of the state, where every point of the law has been declared constitutional and upheld.

The fourth victory has been the conviction in court of Howat, the arch contender, by a jury of his own peers in his own section of the state.

Furthermore, it is not a court for the general regulation of business, of capital, or of labor, but for the protection of the public in an emergency when the processes of production are threatened and all efforts at conciliation have been exhausted. The law adds to the provisions of the second industrial conference: when that fails, then the law takes hold.

Investigations of Producing Conditions

An important provision of the law is that one giving to the court the authority to undertake investigations of operating and producing conditions in the state as affecting any of the industries contemplated in the act. This makes it possible for the court to render a most important service to the public. Mention has been made of the fact that the 1921 legislature modified the law by restoring the separate Public Utilities Commission and uniting the Court of Industrial Relations with the Department of Labor and Industry of the state, and through this union the whole range of authority pertaining to industrial matters in the state is concentrated in one body. Investigations now under way pertain to the supply and distribution of coal. Marketing and prevailing prices charged by local coal dealers are included. The outcome may not be predicted but good may be the result. One other investigation pertained to the continuity of production in the flour milling industry. It is not unreasonable to expect that such reviews of producing conditions may be productive of much that will be of value to the public.

Speaking one final word as to the system here described as a means for establishing a basis for the adjustment of the complex problems in the great industrial relations question in this country today, the Kansas law is open to one significant criticism. This is in the fact that there is still present the disturbing factor of combat between employer and employee. Industrial peace will come only when this is eliminated and a process of adjustment based on co-operative harmony substituted. The Kansas plan does not prevent the full development of voluntary adjustment of difficulties, but it does regulate, however, the methods of combat in the last analysis.

Workers, Training of *658.455*

Apprenticeship—Dream and Reality

By H. E. MILES

Vice-President, Racine-Satterly Company

TO appreciate modern opportunities for trade training we must free our minds of traditional misbeliefs regarding apprenticeship. The halcyon days of apprenticeship never existed. Here and there in England, the cradle of apprenticeship, there were, it is true, halcyon days of guild monopoly, with fathers paying large sums for their sons' indenture in these monopolized trades and their consequent participation in the monopoly privileges, and in addition there were other fortunate apprenticeships of somewhat less value; but there never was a time in England when men entered apprenticeship much more readily than now, or primarily because they were inspired with the desire to master a trade.

All through the Middle Ages from about 1261, when we find the earliest mention of apprenticeship, to 1700, the time of its rapid decline, it was a penal offense in England for anyone except the eldest son of a master who "inherited apprenticeship" to buy or sell merchandise or to create any article embodying skill except after a period of apprenticeship, beginning anywhere from the eighth to the seventeenth year and ending, during most of these centuries, at the twenty-fourth year. Neither could anyone be a freeman without apprenticeship. The wages of common labor were about four pence per day, equivalent in purchasing power to 96 cents in the United States in 1913.

The "Poor-Law Apprenticeship" System

These low wages compelled laborers with large families frequently to resort to the poor rates, and persistent resort to the poor rates or the belief of a Justice of the Peace that the worker's family was too large often made it necessary in law for the justice to seize one or more of the children and indenture them as "poor-law apprentices." Sometimes the children were sent to distant places forever beyond their parents' ken, to masters who had no obligation toward them other than supplying them with food and clothing of the commonest sort. They were, furthermore, not required to see that the children received any instruction. I submit that when in those "glorious days of apprenticeship" the alternative was, on the one hand, "this poor-law enslavement" up to the age of about 24, with wages thereafter as unskilled labor fixed by law at four pence per day and the risk of losing one's children, or on the other, apprenticeship to a trade until 24 with training in the trade assured and with the "freedom of the city" flowing out of this apprenticeship and carrying with it the right to buy and sell and produce merchandise, it presumably was not a greater desire for skill but terror of the alternatives that gave England the number of skilled workers that she had in those centuries.

Witness further that when, in about 1700, after two centuries of what we may call the "bootlegging" of those days, men had persisted in acquiring skill in hidden places, in farmhouses, "in aleys and upon steyers, and houses in corners.[1]" and in selling their products covertly, until finally the right to exercise one's faculties freely in production came to be recognized, apprenticeship rapidly and greatly declined. Incidentally, it may be noted that during the long apprenticeship period of those days little of mathematics or other book learning was taught, and there was complaint then as in our days that so far as the acquirement of skill was concerned the apprenticeship period might have been much shorter. It was made long in order that production might be cheaper.

The following quotations from unquestioned author-

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[1] Joscelyn Dunlop, "English Apprenticeship and Child Labour."

ities may make us better appreciate the relation of apprenticeship to industry at large in those days and now:

> It is sometimes thought that under the apprenticeship system the proportion of skilled to unskilled workmen was greater than at present, but it is doubtful whether this was ever the case.[2]

At the end of the seventeenth century Gregory King reports only 60,000 artisans and craftsmen in England, with an average individual income of £38 per year. Thorold Rogers declares that conditions were so bad throughout the eighteenth century that the poor were virtually enslaved, in fact in some quarters slavery was recommended as an improvement. Considering wages, he writes:

> To the labouring class, King adds vagrants, thieves, and beggars by profession. Including the latter he finds the average yearly income of those who are engaged in these ill-paid pursuits to be about £5, or less than 2 shillings a week. He reckons that their necessary subsistence must require an average of 7 shillings a year more.[3]
>
> At Witney there were threescore blanketers employing 150 looms, and near "3,000 poor people, from children of 8 years old to decrepit old age."
>
> Philanthropists of the late eighteenth century regarded it as a matter for congratulation when the inmates of a charitable home or school would maintain themselves as soon as they could crawl.[4]

HOURS OF LABOR UNDER THE APPRENTICESHIP SYSTEM

The Statute of Artificers (Elizabeth, 1562) was the foundation of English apprenticeship in its highest development from that time to its decline in 1700. During this time the legal hours of labor for all ages were commonly:

> . . . from 5 A.M. to 7 or 8 P.M. from the middle of March to the middle of September, inclusive of breakfast, dinner and drinking . . . not above 2½ hours.[5]

From September to March, the hours were:

> . . . from the spring of day until night. It was not until the nineteenth century that there was any real reduction in the statutory working day.[6]

"A master by his oath could not give his apprentice wages, and the apprentice forfeited thereby his freedom," ruled the London Chamberlain in 1744. The master was strictly accountable for proper treatment of the trade apprentice and the latter's rebellion against the master was punishable by slavery.

Bailey says the condition in 1758 of poor-law apprentices, for whom instruction was never required, was so base as to "force them to leave their masters and enter into crime."

David Dale of the New Lanark Mills, called a philanthropist by his contemporaries, and father-in-law of Robert Owen, entered into arrangements with a philanthropic society in Edinburgh to take over orphan and destitute children in regular batches. English employers did the same.

> Thus a new slave trade grew up in England; children even being bought and sold if, through bankruptcy or other reasons, their original employer desired to part with them before their indentures were complete.[7]

From the condition of the children we can judge the condition of their wage-earning parents.

Children of six years and upward were made to work at tireless machines for twelve or more hours per day. Kindly David Dale sent children

> . . . into the mill at from 5 to 8 years of age; and their hours of labour were from 6 A.M. to 7 P.M., after which the ten schoolmasters performed their part.[8]

ARGUMENTS OF THE TIME AGAINST IMPROVEMENT

In 1819 the chief argument against amelioration was that

> It was cruel to prevent or restrict children's labour because they "must starve" without it.[9]

What father would not indenture his children that fewer of his descendants might suffer this fate, predetermined by the low wages of adult labor fixed by Justices of the Peace who met in each district twice each year for this purpose? And America was part of the British Empire of those days. Those who suffered and those who profited from these conditions were our own lineal ancestors. Not until the law of 1833, promoted and secured by the insistent action of farseeing and humane manufacturers, did relief come.

In 1593 the wages fixed by law for laborers were four pence in winter (equaling 96 cents in U. S. in 1913) and five pence in summer (equaling $1.20 in 1913) and for artisans 8 pence and 7 pence ($1.92 to $1.68)[10] with apprentices, many of them skilled, getting no wages until they became journeymen at 24 years of age, the reward for an apprenticeship service of from 7 to 9 years being, as indicated by above figures, an increase above the laborer's wage of about 60 per cent or 70 cents per day on the basis of wages in the United States in 1913. In a Lancaster mill in 1800 there were 55 apprentices and only 2 journeymen, that is, two employers with wages and 55 of various abilities getting food and clothing only.

During all these centuries England, by fixed policy and legislation, made low wages, and this sort of apprenticeship the basis of her foreign trade and her commercial prosperity. She made herself supreme in skill and commerce, but her wage-earners paid the price.

Apprenticeship was not for the laborer's sake, but for the nation's sake. The apprentices, both skilled and "poor-law," were the beasts of burden, the cart horses, who drew the load of England's prosperity and greatness in which personally they had no share.

Said Thorold Rogers:

> I can conceive nothing more cruel, I had almost said more insolent, than to condemn a laborer to the lowest possible

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[2] *Ibid.*, p. 95.
[3] "Six Centuries of Work and Wages," pp. 463, 464.
[4] J. Dunlop, "English Apprenticeship and Child Labour," p. 98.
[5] *Ibid.*, p. 175.
[6] *Ibid.*, p. 176.
[7] Gilbert Slater, "Making of Modern England," Rev. Ed., p. 52.
[8] *Ibid.*, p. 53.
[9] Hutchins, B. L., and Harrison, A., "History of Factory Legislation," p. 25.
[10] Thorold Rogers, in "Six Centuries of Work and Wages."

wages by an act of Parliament interpreted and enforced by an ubiquitous body of magistrates, whose interest is to screw the pittance down to the lowest conceivable margin, and to inform the stinted recipient that when he had starved on that during the days of his strength, others must work to maintain him in sickness or old age. Now this is what the Statute of Apprenticeship, supplemented by the Poor-Law, did in the days of Elizabeth, and if you go into the streets and alleys of our large towns, and indeed of many English villages, you may meet the fruit of the wickedness of Henry VIII and the policy of Elizabeth's councillors in the degradation and helplessness of your countrymen.

MODERN SUBSTITUTES FOR APPRENTICESHIP

It will comfort and inspire some of us to know that we need not attempt generally "to revive apprenticeship" by a return to the past, and that we have developed in considerable measure our own better way as shown in many factories, large and small.

Apprenticeship is misunderstood in respect to its general applicability. It is desirable for the development of leaders who will cease to be wage-earners almost as soon as trained. It is for about one in the hundred. In three American factories famous for their highly developed apprenticeship courses it now averages one in ninety—a high average. Millions of our workers, possibly 90 per cent, are doing work impossible of apprenticeship instruction of the old sort. The factory training department when rightly developed offers an improved substitute for the old apprenticeship in what is called "Intermittent Apprenticeship." A distinguished manufacturer searches constantly throughout his entire force for average and superior men who want to advance, sends them to his training department to be perfected each in one limited field at a time, with regular shopwork in intervening periods, and by recurrent returns to the training departments lifts them higher and higher at almost negligible cost, and with good wages all the time. He thus fills his best positions from the ranks.

The effect of this method upon the morale of the shop is evident. Every employee knows that, whatever his age or position, he will be given scientific instruction upon proof of desert. Contrast this situation with that of a factory with a justly celebrated four-year apprentice course given to about seventy select youths indentured at about seventeen. When asked what is done for its other 4,000 machine tool workers, an officer of this company said, "Not a damned thing. They can take care of themselves." The general superintendent, however, reports poor results from these 4,000, and wants a training department.

Hundreds of factories are using the factory training department of vestibule school, both for introducing new workers and for upgrading old employees. Many workers 35 per cent to 50 per cent efficient are found to be naturally as capable as others 60 to 80 per cent efficient and are quickly raised to this level.

It is sometimes pathetic, and always inspiring, to see the response of the learners to training, provided, of course, that the training is well given. In the present dull period some factories are developing picked men for greater availability upon the revival of trade, so they can be shifted from place to place to keep the force well balanced. Some are running the training department full force on odd jobs offering diversified and excellent instruction, thus getting necessary production and also holding good men with training.

Employment management 658.4

What the Workman Really Wants[1]

WHAT does the workman want? We know specifically what some people do not wish him to have and what other people insist that he should desire, but let us scrutinize closely what the workman himself really wants. Let us put it very briefly and ask and answer these four questions:

1. What is it?
2. What causes it?
3. What of it?
4. What are we going to do about it?

What Is It?

Just five things:

(*a*) A steady job
(*b*) Adequate real wages
(*c*) A good foreman
(*c*) A voice in settling his own conditions
(*c*) A chance to rise on his merits.

What Causes It?

The nightmare of unemployment, the standard of living, and the unintelligent and unwise handling of workmen individually and in small groups by supervisors who lack energizing and enlightenment and sympathy.

What Of It?

Unrest! Industrial wars and rumors of wars. A state of mind which is fertile soil for the man, often not a workman, who wishes to capitalize the worker's feelings for quite different and subversive purposes.

Men are moved much more by their feelings than by their thoughts. When intelligence, emotions and disposition—the three motive powers of human beings—are appealed to in people lacking necessary information, the fact that your appeal is based on truth has very little to do with the result of those in an exasperated state of mind. What of it? Low production; low morals; little co-operation; readiness to change our social and economic system for others which give no guarantee of betterment.

What Are We Going to Do About It?

Educate! Educate whom? The employer, the superintendents and the foremen, the employes and the public in the art of co-operating harmoniously in "getting a living."

Educate how? By suitable literature; talks, personal contacts, and open forums of supervisors and employes, where a chance to talk back is afforded and where there is an opportunity to air both ignorance and knowledge, truth and untruth.

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[1] From an address by John Calder, Manager Industrial Relations, Swift & Company, delivered May 26, 1921, before the annual convention of the Iowa Manufacturers' Association, at Sioux City, Iowa.

When Is It Justfiable to Expand?

A Principle to Consider before Tying up Resources in Plant and Equipment

By H. P. LOSELY

Engineer, James E. Morrison Company

AS soon as manufacturing activity becomes more intense, managers will again begin to experience the urge to purchase more equipment and to make extensions to their plants. Requests may be made by men in the organization who see opportunities for "savings" and "increased profits," or salesmen may come in and present apparently convincing grounds for using their particular proposal. The main policy of increasing manufacturing facilities may also require consideration. The principles to follow in making recommendations on such contemplated action are worthy of consideration.

The first concept to develop is the value of capital and the return we should expect from its use. The correct estimation of this figure is of prime importance, as the continual use of too low a figure will almost certainly bring the business into an overextended position. An article in the *Annalist* of May 2, 1921, under the initials W. S. S. presents an excellent key to the analysis of balance sheets of manufacturing corporations, and gives 15 cents on the dollar as the ratio of profit to capitalization, although no detailed reason for this figure is given. The writer has arrived at this same 15 per cent by the following reasoning.

Utilization of Financial Resources

We may accept as axiomatic that one of the management ideals is to utilize financial resources to the best possible advantage, and we may further assume that the finances are being so managed that not only are current assets greater than current liabilities, but also a substantial reserve fund is maintained in liquid investments. We have, therefore, fundamentally two factors to consider in making an investment in additional equipment: the rate of return on the "excess capital," and the rate of return on the proposed equipment.

Assuming the investments of excess capital to be in charge of an experienced and level-headed business man who uses all available information, then a return of 100 per cent profit in a period of five years is not extraordinary. This is equivalent to an interest rate of 15 per cent per annum compounded annually. This figure of 100 per cent may not always be attained, and sometimes it may be exceeded.

The experienced investor who buys near the bottom and holds through minor fluctuations to near the top, then sells out and places funds in the bank at 3 per cent, will gain approximately this amount in the long run. If short selling during the period of declining prices is resorted to, the gain will be even greater.

Needless to say this return of 15 per cent on "excess capital" cannot be earned by buying securities whenever the company happens to have idle funds and selling them when cash is required; it requires vigilance, the courage and vision to purchase during times of depression, and the wisdom to sell during excessive inflation. That fluctuations of such magnitude occur to make this high return possible, may not be a particularly brilliant testimonial to management in general and the moral aspect of taking advantage either of bargain counter prices or of inflated markets has been questioned. However, the fact remains that as managers learn more and more to prepare to take advantage of these situations, these preparations will automatically help to reduce the amount of fluctuations actually occurring and are therefore a beneficial influence. The educational process is, however, so slow (as illustrated by the fact that a large number of manufacturers are still operating without adequate cost systems in spite of wide educational efforts) that, for several years to come, the economic organization of affairs will still make possible the annual average earning of 15 per cent on outside investments. We may, therefore, very well make the broad statement that: *Any new equipment which cannot be made to yield an average annual return of 15 per cent after charging off the proper depreciation is a bad investment, since it ties up resources without any compensation.*

We should have fared better if we had left the capital with the company treasurer to get the same return. Of course if the installation is of such magnitude that a funded debt can be created to obtain part of the necessary capital, then only the unfunded portion should be made to show the 15 per cent or more yield after depreciation, interest on the funded debt, etc., are paid. Before proceeding to discuss the yield, the other factors, cost and depreciation, may be reviewed.

Factors in the Cost Estimate

The figure used in the cost estimate should allow a margin for unexpected items and should, of course, include provision for any special work (designing, special trips, etc.), as well as any freight charges and erecting costs. If much of the work is special and no contractors' bids are available, the proposed cost figures

should be carefully scrutinized. In case the proposed installation is of appreciable size it will also be necessary to examine working capital requirements. If large additions to stores or material in process are required, then the financing of this additional burden should receive consideration.

In considering depreciation, which is here understood to include obsolescence, a sharp distinction is to be drawn between special and standard equipment. Usually the former will be worth only scrap value when it is discarded and this scrap value may be relatively high if many standard parts enter into its make-up. The estimate of the life of special equipment is an important feature and where changes in product or in demand for goods are of influence it is well to place the life estimate low. On the other hand, depreciation rates on standard equipment are fairly well established, the obsolescence allowance is low and in case manufacturing changes render the equipment superflous, it can be sold at the loss of depreciation plus setting up and tearing down expenses.

The same theory applies to buildings. If a standard type of building is erected in a suitable neighborhood, the proper allowances are readily determined, whereas a special building or one erected in an out-of-the-way location may be worth little more than a wrecker's price if no use can be made of it. If the proposed item is large, then the probable effect of market fluctuations on its value also should be considered.

RETURN ON EQUIPMENT

The concept of the return on the equipment may now be discussed. While decreased labor cost on the individual operation may be the most obvious item, there may be other factors which entirely outweigh this. The most important principle to observe is that the effect of the proposed installation on the whole production must be considered. A certain breadth of view must be maintained. If the telephone companies figured the revenue from each individual phone and insisted on a profit from each one, there would be no general telephone system today; it is the ubiquity of the telephone which makes the big users willing to pay enough to support the small ones. A story recently appeared in *Nation's Business,* telling of a candy store proprietor who found that his soda fountain was not yielding a profit, so he discontinued it, only to find that his candy business dropped off too and did not pick up until he had restored the "unprofitable" soda fountain. Your head on your shoulders may be worth $10,000 a year; chopped off it might be worth $5 to a medical student. The moral is that whenever a certain activity serves as a support for other activities, a separate valuation of each is dangerous if not entirely out of place.

The value of balancing equipment is generally well enough known, but it does not usually receive the analytic attention to which it is entitled. A case in a clothing factory will serve to bring out the point:

One department, employing some 90 girls, was carefully analyzed and standards were set for each operation. A production of 600 units per day was indicated as standard for the whole department, whereas actually about 420 were being produced. Investigation showed that the main cause of failure to reach standard lay in two operations out of 30; the operators on the other 28 could produce if they were provided with work. Due to certain difficulties beyond control of the foreman, it appeared next to impossible to obtain a greater output from the weak operators, and it was therefore recommended that an additional machine be installed at each of the two weak points. When this was done, production rapidly reached 550 and then gradually approached the 600 mark. It is clear that in this case the return on the investment was not just the output of the two machines. The efficiency of the whole department was raised from 70 per cent to over 90 per cent and the profits on the additional production paid for the machines in a few days. With such a high return there was of course no hesitation in recommending the comparatively trifling investment.

Another case may be presented to show the consideration of the power factor. In this instance, the management of a paper mill was considering the installation of an additional beating machine because the other departments of the mill were obviously always ahead of the beaters. A careful analysis of the whole mill revealed the fact, however, that while the production of the beaters was often below par, this was due to lack of power. The mill was using both steam- and waterpower and the capacity of the steam engines alone was insufficient; whenever the waterpower ran low the beater men were obliged to "go easy" on the rolls and leave the stock longer in the machine. The addition of the extra beater would have resulted only in additional frictional load on the transmission and have made the situation worse. A daily production of 13,000 lb. was costing an average of 9.8 cents per lb. The possible production with ample power provision was 15,000 lb. and the estimated cost for additional installation was $5,000. Allowing for cost of additional power the unit cost would have been reduced to 9.5 cents per lb., or a saving in manufacturing cost of $45 a day. This would have paid for the equipment out of manufacturing profits alone in 110 days. Here again the yield was so far above the 15 per cent requirement that there was no hesitation in recommending it.

DETERMINING THE NEED FOR NEW PLANT

An example of a different character may serve as a warning to concerns contemplating building new plants to replace old ones. In this case, one company was operating three mills in three different locations of one city. Plants B and C were more modern and, having been designed according to the latest experience, were operating somewhat more efficiently than the older plant A. This latter was apparently in a poor location and the general opinion of the executives was that sooner or later operation would have to be discontinued and a new mill (proposed plant D) built next to plant C, which had a good location with railroad connection. The engineer sat down to make a report on the situation with somewhat of a "hunch" that a new mill

should be built and rather predisposed to recommend that plans be commenced at once. While certain water-power rights were being utilized to advantage, the chief factor militating against the old mill was its location on a hill, causing hauling costs on raw material and finished product. Also the layout of the mill was the cause of a small amount of excess inside labor. A concise tabulation of all the factors was prepared and the obvious conclusion was as much a surprise to the engineer as to the executives. The five factors considered were:

1. Power
2. Building and land investment
3. Transportation
4. Building efficiency.
5. Supervision and labor situation

1. *Power*

Plant A		
(*a*) Steam: 7,200 tons coal at $6		$43,200
Interest and depreciation at 12½ per cent on $20,000—machinery	2,500	
Firemen, etc.	11,000	
		$56,700
(*b*) Water: Interest on hydraulic valuation	$2,500	
Reserve for maintenance	800	3,300
Total Power A		$60,000
Plant D		
(*a*) Steam on same basis		$56,700
(*b*) Electric Power additional		8,500
Total Power D		$65,200

2. *Building and Land Investment.* The land factor is ignored as the company owned land in both of the considered locations and there was only a small difference in the market value. The old building was carried at $80,000. Due to increased cost of construction it was conservatively estimated that at least $120,000 would have to be spent to put up a new building of equal capacity. The old building was already partially depreciated on the books; so an obsolescence charge of 7½ per cent was considered conservative, whereas on a new building it would be necessary to put this rate at not less than 8½ per cent. The interest rate of 8 per cent was obtained by computing a mortgage at 6 per cent and the balance at 15 per cent. The figures therefore stood:

Plant A	Per Cent
Interest	8
Depreciation and obsolescence	7½
Maintenance and insurance	1½
Total 17 per cent on $80,000 = $13,600	

Plant D	Per Cent
Interest	8
Depreciation and obsolescence	8½
Maintenance	1½
Total 18 per cent on $120,000 = $21,600	

3. *Transportation.* After a preliminary casting up of figures, it became apparent that the situation was not at all decided against the old site. A little research work revealed the fact that the hauling was being done by an outside teamster on a day basis and full value was not being given. The grade on a short section of the road was steep and had instilled all concerned with the idea that motor trucks could not be used the year round. Some demonstration runs were arranged and after a few days' test it was apparent that the cost of hauling could be cut from $1 per ton by team to 50 cents by truck. The carting away of ashes was usually contracted for fill-in purposes. The situation then stood:

Plant A	
40 tons per day at 50 cents for 300 days	$6,000
Ashes daily $2.50 a day for 300 days	750
Total Plant A	$6,750
Plant D	
Raw and finished material loaded direct from siding	
Ashes daily $2 a day for 300 days	$600
Total Plant D	$600

4. *Building Efficiency.* An investigation of the excessive handling in the old plant showed that the total number of men affected was only 26 and an analysis of their activities showed that the most that could be eliminated would be 3. It seemed reasonable, therefore, to charge the old mill with the labor cost of these three men, approximately $15 per day or a total of $4,500 per year. It was later shown that changes in the old building could be made to reduce this, but this factor is at present ignored.

5. *Supervision and Labor Situation.* How much advantage is to be obtained from centralized production will always depend on the management as well as on the size of the mills, number of men employed, location of men's homes, officials' traveling time and other factors. In many cases it is more a matter of sentiment than of dollars and cents. In this case there were many employees who had been with the company several years and had homes convenient to the plant. A change would have seriously inconvenienced them; would have cost time and money and disorganized production. This would have cost far more than the slight advantage to the few officials who had business in all three plants and so had to go from one to another.

Summary Estimates

The summary of the estimates for the two plants indicated the following operation costs affected by the proposed change:

Item	Present Plant A	Proposed Plant D
1. Power cost	$60,000	$65,200
2. Building charges	13,600	21,600
3. Transportation	6,750	600
4. Inefficiency of building A	4,500	.....
	$84,850	$87,400

It is quite evident from the above that a new plant would have been at a disadvantage. In this particular case there was no further question of putting up a new building and the policy of the company, which had been wavering, and therefore unfavorable to any progressive developments, was settled for at least a few

years and both officials and employees knew where they stood.

This example is explained at such length because it can be used to point out an important consideration in respect to Item 2. It might have been that the disadvantage of the old building was somewhat more serious than shown—say to the extent of a further annual charge of $3,000—so that the comparison would indicate the advisability of a new building. Such is not the case, however, unless the old building can be disposed of for $80,000.

It must be kept in mind that as any art progresses and newer machinery and methods become available, the older plants are to be written off until they reach the rating at which they can be sold as scrap or are to be adapted to other purposes. Thus, if the proposed new plant indicated for the old plant a transportation disadvantage of $8,150 and a building inefficiency of $8,450 annually, we would make the building charges $10,200, so as to balance A and D as follows:

Item	Plant A	Plant D
1. Power cost	$60,000	$65,200
2. Building charges	10,200	21,600
3. Transportation	8,750	600
4. Building inefficiency	8,450	.....
	$87,400	$87,400

In other words, instead of capitalizing the building at $80,000 we would capitalize the building at only $60,000, giving at 17 per cent an annual charge of $10,200. The $20,000 difference would be written off as obsolescence.

The Compelling Basis

Stories have been widely circulated of the bold manner in which steel plants have been torn down after brief operation because further manufacturing economies could be made. From this indefinite premise, many managers have drawn the conclusion that the big thing to do is to scrap a plant if a new one can show lower production costs than the plant they have. This policy may, however, be anything but wise. If it is necessary to meet legitimate competition, the logical thing to do is first to write off the obsolescence necessary to put the plant on a competing basis. The loss thus incurred may be very much less than would be entailed by scrapping the old plant and going through the strain of organization of a new one. The time to scrap an old plant or old equipment is when the new arrangement can show a production cost below that of the old arrangement after depreciating existing fixed assets to scrap or market value. The new capital should be charged with the interest on any funded debt and show a steady yield of 15 per cent on the unfunded part taken from the company treasury. One of the main disadvantages encountered in American industry is the excessive investment in plant. It is part of the work of the management engineer to guard against making heavy fixed investments which may soon become obsolete and a burden on further progress.

Cost engineering 658.51

Cost Engineering as a Profession

By H. W. MAYNARD

Cost Accountant, Scovell, Wellington & Company

THE analysis of cost in a small factory or one employing simple processes can be performed by the general manager; but where the product is complicated, and where large and small orders for different kinds of material follow each other in succession, the proper analysis requires more time than the manager can afford to give, and calls for greater technical knowledge than a "cost clerk" possesses. It becomes an engineering function and requires the services of men with technical training and experience to do what may be called cost engineering.

Function of the Cost Accounting Is Limited

The cost engineer is not to be confused with the cost accountant. The function of the cost accounting department is threefold. First, it reports in detail the expenses of the factory for the benefit of the superintendent and enables him to maintain the proper control over his variable expenses. Second, it provides summarized statements for the management, which give a clear view of plant operation so that it can be judged in its relation to finance and sales. Third, it determines the cost of each order (or each kind of product for the accounting period) in its elements of material, labor, and burden. A cost accountant has fulfilled his responsibility in this direction when he has delivered a record of the finished cost of the order. In many plants the work ends there, and the company's files become filled with valuable but untouched cost data, through which many of the problems of operation might be solved. This hiatus may constitute a real menace to the company's prosperity.

The costs of the orders should be analyzed. The analysis should be broad enough to cover the accuracy of the estimate on which the order was taken, and the efficiency of the factory operations; and the costs should be put in such form as to be available for estimating on future business. This work cannot be effectively performed by the cost accountant, for his supervision of the clerical force, and the demands upon his time in connection with routine business and the preparation of periodical statements, prevent him from devoting the proper amount of time to analysis. The results should be studied by a cost engineer.

Function of the Cost Engineer

Such an engineer does not need to be a cost accountant. He is not concerned with the distribution of overhead, and is not responsible for the burden rates, which are established by the cost accountant, the comptroller, or the auditor. He does need, however, to have a full working knowledge of the factory operations and of the methods of accumulating charges to production

orders for material and labor. Hence he will find a good engineering training invaluable.

It is the duty of the cost engineer to make a study of the charges to all important orders. He compares the actual cost with the estimated value, to learn whether the expected profit has been made. Too small a profit means an erroneous estimate, inefficient shop operation, or a wrong sales policy; too large a profit may be just as bad because it probably indicates that other orders are being lost on account of high prices. A comparison of detailed values of actual and estimated material and labor will indicate points for further investigation. There may be inaccuracies to be corrected and prevented in the future. Too much material may have been charged to the order, or the estimate may have failed to make sufficient allowance for waste. Discrepancies in labor values may indicate exceptional efficiency or inefficiency. An excessive burden charge may have occurred because the work was performed on a machine larger than necessary. If a loss has occurred, nothing can be done to recover the vanished profit; the important point is to prevent recurrence of the loss. If the shop expense is higher than the estimate, and cannot be reduced, the estimates must be changed accordingly.

Investigation in the Shop

The investigation may take the cost engineer to the shop, where he talks with the superintendent or the foreman, and learns their story of the order. The shop managers should understand the point of view of the cost man, and realize clearly the effect in profit or loss of good or poor work on the part of their organization. The cost engineer should keep in close touch with them, and he can help to bring about a proper and friendly understanding with them.

He should be able mentally to translate costs into terms of factory operations. He needs to visit the shop, not occasionally, but frequently, and as he passes from one department to another he should visualize the material before him in terms of value, either as cost per pound or as cost per machine hour. He will gradually develop a unit of measure which his eyes can apply to the partly finished material and the completed product.

Vital facts summarized from the analyses should be shown in graphic form and clearly explained.

Estimating for New Business

The estimating department may or may not be combined with the cost engineering function, depending upon the organization and the nature of the business. Sometimes the estimating department is handled in a purely routine manner. The estimators are provided with standard unit costs for material, labor, and burden, and are in no way concerned with the source or the accuracy of these standards. In such cases it is the duty of the cost engineer, in making the analysis of each order, to accumulate data on the cost of operations and turn it over, when completed, to the estimators.

Sometimes the two functions are partly or wholly combined. The writer was for several years in charge of the cost engineering work at a plant in the Middle West which manufactured hoisting and conveying machinery. The product covered an extremely wide range, varying in size from small monorail trolleys to traveling bridge tramways weighing over one million pounds, and including many special and unusual machines. It was necessary for cost analysis to be highly developed. For each proposed machine the designers prepared an engineering estimate giving an analysis, by weight only, into major and, in some cases, minor elements. This estimate of weight was delivered to the cost engineers, who made a sufficient study of the proposed design to determine the previous costs which would best apply. The weights were extended at the proper unit costs per pound, and the price was set for quotation by the sales department.

When the order for a special machine was received, it was given to the cost engineering department, where the production order describing it was prepared according to a definitely established phraseology; it was also divided into suborders for manufacturing purposes. The method of division into suborders was carefully developed and, so far as possible, was standardized, so that direct comparison could be made between costs on similar machines. The cost engineers followed the order through the shop; on its completion the bills of material and the labor sheets were analyzed according to the method already described and, in the case of new and complicated machinery, were given special analysis in conjunction with a study of the detailed drawings. Through this work, errors in the costs were eliminated and the data were given such explanatory notes and were so recorded as to be immediately available for further estimating. A classified list of costs of unusual items was also maintained, with proper cross references so that they could be located without the need of relying upon the memory of any person.

Special Investigations and Problems

The cost engineer meets with many problems. For example, a machine for stranding wires by twisting them together has bobbins that hold 5,000 ft. The cost of setting up the machine is greater than the cost of running off the full bobbins. Suppose that an urgent inquiry comes for the delivery of a unit of product 6,000 ft. long. It will involve one complete run of a machine and a second set-up for the extra 1,000 ft. How much more should the customer be charged for putting through this single order than for waiting until it would fit in with an economical production schedule? Again, how important is it to maintain such a schedule; how much is the difference in cost between running large and small orders? Or again, a factory is willing to take small special orders at a loss, provided they are combined with large, profitable contracts. What will be the loss on small orders, and what is the proper balance between special and standard work to give a reasonable profit on the customer's account?

The cost engineer is in a position to make recommendations for efficiency and profit. For example, the manufacture of a special machine requires eight steel

castings of a new pattern. The factory does not own a foundry, and the castings must come from a distance. When they are machined, one or two are likely to develop flaws. As a result there is a delay in shipment, a delay in payment, a dissatisfied customer, and a nearly complete machine obstructing the assembly floor. Will it not pay to order ten castings in place of eight and scrap two, to insure shipment on the promised date?

Some special machines which were being built during 1917 in various sizes and types required motors as a small but essential part. Deliveries of motors took several months, and orders for the machines were coming faster than they could be handled. It would have paid many times over to carry a considerable inventory of small motors, in the voltages most commonly used, for both direct and alternating current, in order to expedite the shipment of machines while the demand, at a good price, lasted.

Possibilities of Development

The cost engineer who has ambition, ability, and tact can extend his activities almost indefinitely. He may become the most useful point of contact between the engineering department, the sales department, the cost accountants, and the factory, and may be the means by which divergent interests are brought together.

The cost engineer requires the ability to reason analytically and clearly, and to follow a problem to its farthest ramifications. Most important of all, he needs the right sort of personality. If his attitude is arbitrary or stiff, if he is unable or unwilling to understand the point of view of widely differing interests, if he cannot modify his opinions week by week as new information is obtained, he will not succeed as a cost engineer.

If, however, he possesses the necessary traits, he will find himself engaged in one of the most interesting professions in industry. Costs are live things. A cost is never definitely established. It will play tricks when one least expects it.

In addition to the interest of the work itself, cost engineering offers one of the best channels by which a man may pass from a minor to a major position. The opportunities for acquaintance with many sides of the business are great, and the experience alone is well worth the effort expended upon it.

Cost accounting *657.524*

Losing a Profit Through Averages

By G. W. GREENWOOD

Secretary, United Refractories Company

WE are all fairly familiar with the use made of averages by insurance companies. This use is sound. Thoughtless people accordingly fall into the habit of thinking that if they take an average covering a sufficiently long period and many items, the figures can be safely used in any calculation. The following example, though purely hypothetical, is an instance of such fallacious reasoning—reasoning all too common.

A company engaged in the manufacture of brick is supplied with coal from its own mine, using 1,000 tons a month throughout the year. Seeing an opportunity of making money by selling coal as well as making brick, they sold 1,000 tons a month during the last four months of the year, making an output of 16,000 tons from their coal mine for the year.

The cost of getting out the coal for the entire year averaged $4 per ton, and for the 4,000 tons sold they received $5 per ton, so there should be a profit on the amount sold.

Where the Fallacy Lies

Let us now look for the fallacy in the following reasoning: The average cost throughout the year was $4 per ton, and the price of the coal sold was $5 per ton, making a profit of $4,000. In addition, the company had for its own use, coal at an average cost of $4 per ton, while competitors were paying $5 per ton, or more, during the last four months of the year, which would be an added gain of $4,000 to be credited to their coal mine, so that this operation would be entitled to a credit of $8,000 for the year. Is not this seemingly sound reasoning?

Unable to trace the $8,000 to its lair, they conduct an investigation. It is found that for the first eight months the cost of getting out the coal for their own use was $2 per ton. But at the beginning of September, tempted by an opportunity of selling coal for $5 per ton, they doubled their output and sold the balance. But to accomplish this, they had to meet the increase in costs of every description, because every other operation in their vicinity was also increasing its output, and several mines, which had been idle, started up. The number of jobs suddenly became far in excess of the number of men, so that the direct costs and the cost of inefficiency increased at a greater rate than the output; for it does not follow in the least that increased production results in decreased cost. So the brick company finds that during the last four months of the year the cost of getting out coal was $6 per ton, which gives for the year the average of $4 per ton; derived from 8,000 tons at $2 per ton and 8,000 tons at $6 per ton.

A Dollar a Ton Loss

Thus they were losing a dollar a ton on all that they sold; and instead of an advantage of a dollar a ton over competitors who bought their coal, they were using their own six-dollar coal, while competitors bought theirs for $5. In other words, such a loss of $8,000 can, by using averages for a year, be converted into an apparent profit of $8,000.

In the realm of accounting, there is but one situation worse than having no accounting system at all; and that is to have a poor one. The correct use of statistics is not as simple as it may seem.

As stated initially, the example is hypothetical; but the fallacious reasoning employed is by no means so rare as one could wish.

THE LABOR SUMMARY

Statistics and News from Industry

Employment, Industrial *331.1*

Employment Continues Its Downward Trend

THE downward trend in employment still continues, and according to test surveys conducted by the U. S. Employment Service there was a drop during the month of July of 1.1 per cent in the numbers of workers employed as compared with the figures for the month previous.

The extent of this trend in the various industries is shown in detail in Table 1, the figures being those compiled by the Employment Service from returns made by 1,428 firms in 65 industrial centers. Each of these firms normally employs 500 or more workers, and as shown by the table their net loss from June to July was 16,914, or 1.1 per cent, and their total since the first of the year 177,924, or 7.3 per cent.

An analysis of the returns would seem to indicate, in the opinion of the Director General of the Employment Service, that in the majority of instances where there has been improvement it is primarily traceable to the harvest or other seasonal agricultural activities, and, secondarily, to material gains in railroad occupations, which have to do in the main with repairs to rolling stock and roadbeds.

TABLE I. THE TREND OF EMPLOYMENT IN AMERICAN INDUSTRIES DURING JUNE AND JULY, 1921.
(Compiled by the U. S. Employment Service, U. S. Dept. of Labor)

Industrial Group	Number on Pay-Roll		Net Change June to July	Net Change Since Jan. 1921
	June 30	July 31		
1. Food and kindred products	125,711	123,871	—1,840	—13,573
2. Textiles and their products	256,319	260,460	+4,141	+36,755
3. Iron and steel and their products	325,257	300,441	—24,816	—143,313
4. Lumber and its manufacture	22,679	22,736	+57	—1,282
5. Leather and its finished products	49,936	52,781	+2,845	+13,396
6. Paper and printing	49,802	49,878	+76	—2,987
7. Liquor and beverages	1,758	1,551	—207	—196
8. Chemicals and allied products	71,858	70,503	—1,355	—14,300
9. Stone, clay, and glass products	14,596	11,110	—3,486	—3,992
10. Metals and metal products—other than iron and steel	72,963	71,663	—1,300	—8,001
11. Tobacco manufacturers	29,825	30,666	+841	+2,387
12. Vehicles for land transportation	172,882	180,148	+7,266	+86,296
13. Railroad repair shops	54,710	60,225	+5,515	—2,893
14. Miscellaneous industries	278,828	274,177	—4,651	—66,221
Total	1,527,124	1,510,210	—16,914	—117,924

Of the 14 industrial groups seven (textiles, lumber, leather, paper and printing, tobacco, vehicles for land transportation, and railroad repairs shops) show an increase in employment totaling 20,741 while the remaining seven show a decrease of 37,655. The relation of these increases and decreases to the figures reported for the first six months of the year is graphically shown by Fig. 1.

On the basis of geographical distribution 27 cities out of the 65 reporting show a total gain of 21,152 workers while the decrease in the remaining 38 cities was 38,066. A list of the 65 cities together with the amounts of increases and decreases and the percentage change in each case is given on the following page.

As in previous bulletins the Employment Service makes available comments concerning the status of employment throughout the country and from this section the following paragraph has been prepared:

New England District (Me., N. H., Vt., Mass., R. I., and Conn.). Unemployment and part-time continue in practically all lines, particularly in the metal and building trades and transportation circles. Certain textiles show a marked improvement, frequently reaching normal and even exceeding it. Orders for shoes are also being taken. There is a slump in building operations, however, as indicated by reports which show that contracts awarded in the six New England States for the first half of 1921 aggregate $81,419,000, as against $178,730,000 for the same period in 1920. Retail sales have fallen generally.

Middle Atlantic Division (N. Y., N. J., and Pa.). There is little change in the situation as regards employment. In spite of settlement of controversies in the building trades, building has not materially increased. Automobile and allied industries report a falling off in demand.

East North Central District (Ohio, Ill., Ind., Mich. and Wis.). Employment conditions are hampering efforts that are being made to stabilize prices, and retail trade suffers accordingly; also transportation problems still interfere to a large extent with the general revival of business. The acute situation in steel is another factor that looms large in the present depression. Housing is easier, and work on public improvement has relieved unemployment to some extent.

West North Central District (Minn., Iowa, Mo., N. D., S. D., Neb., and Kan.). With the harvesting of the wheat crop, conditions generally have very definitely improved. At Kansas City, receipts of wheat broke all records, while milling operations throughout the district have begun on a full-time basis. The beneficial effects of the bumper crop are strongly reflected in railroad occupations, packing plants, and the building trades, and while export orders are falling off, they still constitute a respectable portion of the business on the books of the millers and packers. Retailing has slowed down somewhat.

South Atlantic District (Del., Md., Va., W. Va., N. C., S. C., Ga., and Fla., also the D. of C.). With the exception of encouraging increases in employment among railroad forces, the industrial employment situation throughout the district shows little improvement. Textiles are virtually holding their own. Unskilled steel and iron and metal workers generally constitute the largest number of workers at present unemployed. The building trades are generally active. Coal mining continues at a low ebb, though with some improvement in southern West Virginia.

East South Central District (Ky., Tenn., Ala., and Miss.). Several large manufacturing plants throughout the district have shut down temporarily, while many others are working on a part-time basis. Coal shows no improvement. The stagnation in lumber continues, with little demand and sales usually at figures lower than production costs. Mercantile establishments generally have maintained their usual forces.

West South Central District (Ark., La., Okla., and Texas). Agricultural demands have eased the employment situation in some of the larger cities, while general conditions are expected to show betterment as a result of extension of credits by the Federal Reserve Board for handling the coming cotton crop. There is a large amount of residence construction, road work, and other public improvements under way. Mercantile trade is steady. Oil, railroad repair-shops, and packing houses are quiet. Lumber, with a falling off in the foreign demand, is dull, a number of mills being closed and others operating on reduced schedules.

Mountain District (Mont., Idaho, Wyo., Col., N. M., Utah., Ariz., and Nev.). There are increased opportunities for employment in many localities throughout the district. While mining and allied industries show little improvement, the renewal of railroad activities has considerably relieved the situation. Several cities report building programs. A slowing up of public improvements is offset by seasonal demands for agricultural workers.

Pacific Division (Wash., Ore., and Cal.). Many workers in shipping and building trades are idle as the result of industrial controversies. There is slow and only partial recovery in lumber, many plants operating with reduced forces, and others being closed. Fishing, fruit, and vegetable industries are more active. Shipbuilding is slackening, with further reduction expected. Lower construction costs have also helped to revive home building in some sections, but no great momentum has yet been gained.

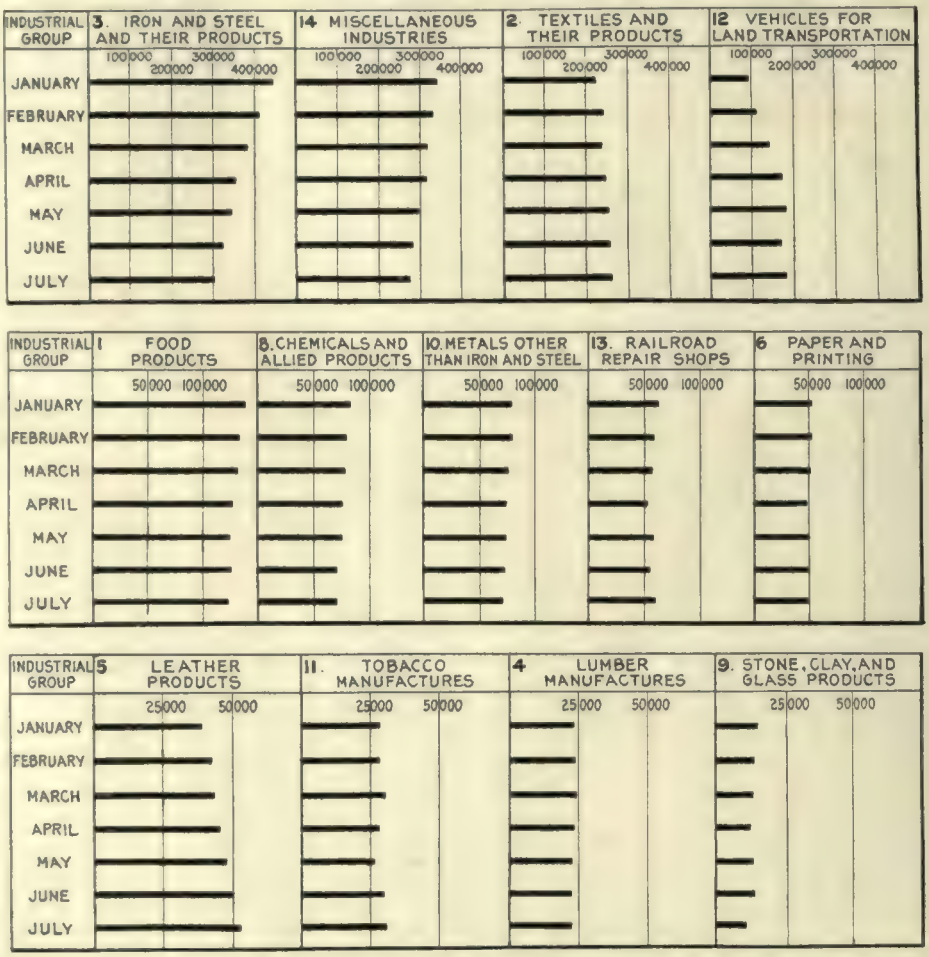

FIG. 1 THE TREND OF EMPLOYMENT IN AMERICAN INDUSTRIES, JANUARY TO JULY, 1921

CITIES REPORTING A DECREASE IN EMPLOYMENT IN JULY, 1921

Cities	Amount of Decrease	Per Cent Decrease From June 30
Youngstown, Ohio	4,927	22.8
Chattanooga, Tenn	971	15.6
Yonkers, N. Y	1,687	12.8
Indianapolis, Ind	1,352	10.6
San Francisco, Cal	597	8.46
Grand Rapids, Mich	313	8.7
Toledo, Ohio	1,130	8.2
Camden, N. J	2,123	7.5
Cincinnati, Ohio	945	7.5
Perth Amboy, N. J	989	7.3
Bridgeport, Conn	1,173	7.
St. Louis, Mo	998	6.09
Cleveland, Ohio	4,324	6.6
Birmingham, Ala	1,415	6.5
Pittsburgh, Pa	3,926	5.9
Kansas City, Kan	726	5.57
Newark, N. J	1,877	5.2
Trenton, N. J	544	4.5
Providence, R. I	554	4.
Peoria, Ill	82	3.9
Johnstown, Pa	335	3.3
New Haven, Conn	369	3.3
Worcester, Mass	563	3.27
Boston, Mass	1,408	2.58
Columbus, Ohio	100	1.7
Waterbury, Conn	144	1.5
Baltimore, Md	433	1.5
Louisville, Ky	100	1.5
New York, N. Y	1,914	1.32
Jersey City, N. J	153	1.2
Paterson, N. J	93	1.18
Reading, Pa	171	1.05
Rochester, N. Y	308	1.04
Chicago, Ill	1,229	.77
Omaha, Neb	49	.48
Atlanta, Ga	36	.45
Passaic, N. J	6	.04
Fall River, Mass	2	.007
TOTAL DECREASE IN 38 CITIES	38,066	

CITIES REPORTING AN INCREASE IN EMPLOYMENT IN JULY, 1921

Cities	Amount of Increase	Per Cent Increase From June 30
Denver, Col.	258	16.5
Portland, Ore.	794	14.7
Brockton, Mass.	1,374	12.6
Lawrence, Mass.	2,678	11.5
St. Paul, Minn.	809	9.4
Buffalo, N. Y.	1,352	6.34
Detroit, Mich.	7,905	6.07
Milwaukee, Wis.	1,695	5.
Niagara Falls, N. Y.	175	4.8
Manchester, N. H.	738	3.35
Kansas City, Mo.	224	3.1
Richmond, Va.	318	3.05
Los Angeles, Cal.	677	2.97
Syracuse, N. Y.	202	2.34
Seattle, Wash.	45	2.3
Flint, Mich.	395	2.
New Orleans, La.	129	1.8
Albany-Schenectady, N. Y.	282	1.5
Bayonne, N. J.	135	1.3
Dayton, Ohio.	126	1.3
Sioux City, Ia.	29	1.19
New Bedford, Mass.	239	.75
Minneapolis, Minn.	83	.7
Lowell, Mass.	72	.58
Philadelphia, Pa.	175	.18
Springfield, Mass.	15	.07
TOTAL INCREASE IN 27 CITIES..	21,152	

Cost of Living *331.2*

The Cost of Living Decreases Slightly

THE cost of living dropped but 0.7 of one per cent during the month of July, according to data gathered by the National Industrial Conference (New York). The figures upon which this statement is based, and given below in detail, show that changes took place in but two of the items which go to make up the average family budget, namely, clothing, which dropped 3.5 per cent, and sundries, which dropped 1.1 per cent. Living costs are still high, however, according to the Board, 62 per cent above the levels of 1914.

In announcing this month's figures the Board calls particular attention to the fact that the data for July differs somewhat from that presented last month, this variation being due to the fact that in the previous statement food prices for June were used, while in the data given below the revised figures for July 15 were employed, which take into account an increase in food costs of nearly 3 per cent within the month.

Item of Expenditure	Relative Weight in Budget	Per Cent Increase Between July, 1914, and July	August	Per Cent Decrease July to August
Food	43.1	48	48	0
Shelter	17.7	69	69	0
Clothing	13.2	64	59	3.5
Fuel & light.	5.6	79	79	0
Sundries	20.4	85	83	1.1
All items....	100.0	63.1	62.0	0.7

The monthly variations in the cost of living since July, 1914, as reported by the National Industrial Conference Board are plotted in curve B of Fig. 2, while

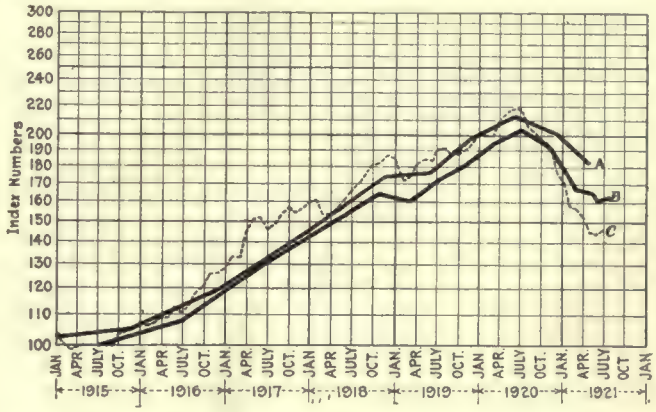

FIG. 2 THE TREND OF COST OF LIVING IN THE UNITED STATES
Curve A——As Reported by the U. S. Bureau of Labor Statistics.
Curve B—As Reported by the National Industrial Conference Board.
Curve C—Retail Price of 22 Articles of Food as Reported by the U. S. Bureau of Labor Statistics

curve C of the same figure shows the variations in the retail prices of the 22 principal articles of food consumed by American families. These latter figures are compiled monthly by the United States Bureau of Labor Statistics, and are the ones used by the Conference Board in making up its monthly report on the cost of living.

The United States Bureau of Labor Statistics also issues in addition to its data concerning the trend of retail food prices, semiannual figures showing the trend of prices in the other items which make up the family budget. These figures of the Bureau covering the first

TABLE 2. PER CENT CHANGES IN COST OF LIVING IN THE UNITED STATES DECEMBER, 1914, TO MAY, 1921.
(Compiled by the U. S. Bureau of Labor Statistics—Average Prices for the Year 1913=100).

INCREASE IN THE COST OF LIVING BETWEEN DEC., 1914, AND	ALL ITEMS (weighted)	FOOD	CLOTHING	HOUSING	FUEL AND LIGHT	FURNITURE AND FURNISHINGS	MISCELLANEOUS
December, 1915	5.1	5.0	4.7	1.5	1.0	10.6	7.4
December, 1916	18.3	26.0	20.0	2.3	8.4	27.8	18.3
December, 1917	42.4	57.0	49.1	5.1	24.1	50.6	40.5
December, 1918	74.4	87.0	105.3	9.2	47.9	113.6	65.8
June, 1919	77.3	84.0	114.5	14.2	45.6	125.1	73.2
December, 1919	99.3	97.0	168.7	25.3	56.8	163.5	90.2
June, 1920	116.5	119.0	187.5	34.9	71.9	192.7	101.4
December, 1920	100.4	78.0	158.5	51.1	94.9	185.4	108.2
May, 1921	80.4	44.7	122.6	59.0	81.6	147.7	108.8

half of the year have just been issued, and are presented in Table 2 and curve A of Fig. 2. It will be noted from an inspection of the curve that while the figures are somewhat higher than those reported by the National Industrial Conference Board the per cent difference between the two is not great.

Wages *331.2*

The Trend of Wages

STATISTICS compiled by the United States Bureau of Labor Statistics covering selected industries and also by the New York State Department of Labor indicate further decreases in wages and earnings for the last periods investigated. Two tables are presented by the Bureau of Labor Statistics, one giving index numbers and the other numerical data for 13 industries. The period covered is from January, 1920, to June of the present year. Table 3 presents this information, the numbers for the year 1920 being, however, omitted.

Turning to the index numbers (Table 3), it will be seen that there has been a sharp drop in earnings in the iron and steel industries, and a smaller decrease in car building and repairing, and in paper making. In the other 10 industries there have been slight increases. The corresponding earnings in industries show for the iron and steel industries a drop on the half-monthly basis of from $75.10 to $43.90. On the same basis the car building industry shows a drop of from $70.05 to $66.31. In the paper-making industry the decrease has been from $25.20 a week to $24.53.

Turning now to the statistics for the State of New York, taking the earnings in June, 1914 as 100, the corresponding index numbers for the first six months of this year were respectively 217, 211, 212, 206, 204, 202. The amount earned in the week including June 15, 1914, was $12.70. The earnings for the week including the 15th of each of the first six months of this year are respectively $27.61, $26.77, $26.97, $26.20, $25.86, and $25.71.

Of the 14 industries reporting to the Bureau of Labor Statistics during July, 11 show a wage rate change. Of these one manufacturer of men's ready-made clothing reported an increase in per capita earnings for July over June. The facts with regard to the major industries, somewhat condensed from the original reports, are as follows:

Iron and Steel. In one mill, 75 per cent of the men were reduced approximately 18 per cent in wages. Four establishments reported wage rate decreases of 15 per cent affecting the entire force in two establishments, 38 per cent of the force in third establishment, and salaried foremen and rollers only in the fourth establishment. A wage rate decrease of approximately 10 per cent affecting the entire force was reported by four plants. One firm cut the wages of 10 per cent of the force 9 per cent.

Automobiles. The entire force of one establishment was reduced 20 per cent in wages. One plant reported a wage rate decrease of approximately 11 per cent, affecting 5 per cent of the employees, while another plant reduced the wages of all employees 10 per cent. Although more time is being worked in this industry, the per capita earnings show a decrease of 2.9 per cent when comparing June and July.

Car Building and Repairing. A large number of car building employees were affected by the decision handed down by the U. S. Railroad Labor Board. The exact effect of this decision cannot be estimated but it is doubtless the greatest factor in the changes in wage rates noted by this report, which shows a decrease of approximately 12 per cent in the general wage level. The per capita earnings for July are 12.7 per cent less than for June.

Bituminous Coal. Less time was worked during this period, as market conditions were dull. The per capita earnings for July are 7.3 per cent less than for June.

Men's Ready-Made Clothing. One establishment made a decrease of 15 per cent to 68 per cent of the force. In two concerns a 10 per cent decrease was made in rates of wages, affecting all employees in one concern, but the number affected in the second concern was not stated. Increased production was reported, and the per capita earnings for July show an increase of 4.4 per cent over those for June.

Leather. A wage rate decrease of 10 per cent was made to all employees in one tannery. The per capita earnings for July show a decrease of 3.5 per cent from June figures.

Boots and Shoes. An increase of 5 per cent was granted to 3 per cent of the men in one factory, while in another factory an increase was made but no specific data given. Per capita earnings for June decreased 3.4 per cent over July.

TABLE 3. AVERAGE EARNINGS IN SELECTED INDUSTRIES DURING 1921

	Iron and Steel	Automobile Manufacturing	Car Building and Repairing	Cotton Manufacturing	Cotton Finishing	Hosiery and Underwear	Woolen	Silk	Men's Clothing	Leather	Boots and Shoes	Paper Making	Cigar Manufacturing
Index Numbers[1]													
January	115	82	124	99	102	96	112	113	105	99	98	111	112
February	99	89	119	101	107	102	104	124	116	98	113	110	103
March	93	89	117	101	108	103	112	117	130	93	111	109	115
April	81	108	118	102	109	104	113	124	128	100	109	109	108
May	74	115	115	101	107	104	118	123	115	98	106	104	112
June	67	112	118	104	109	104	117	121	118	100	109	108	113
Numerical Data	Per ½ Month	Per Week	Per ½ Month	Per Week	Per Week	Per Week	Per Week	Per 2 Weeks	Per Week	Per Week	Per Week	Per Week	Per Week
January	$75.10	$24.05	$70.05	$16.62	$21.03	$15.19	$22.52	$41.70	$26.85	$22.92	$20.92	$25.20	$19.35
February	64.75	26.00	67.38	17.09	21.98	16.19	20.89	45.56	29.57	22.67	24.21	24.80	17.75
March	61.11	26.13	66.23	16.99	22.13	16.36	22.45	43.08	33.20	21.41	23.80	24.67	19.89
April	53.11	31.66	66.67	17.26	22.28	16.48	22.64	45.55	32.74	23.18	23.35	24.73	18.67
May	48.77	33.75	65.01	17.02	22.00	16.51	23.62	45.17	29.47	22.75	22.65	23.61	19.35
June	43.90	32.78	66.31	17.56	22.40	16.58	23.40	44.51	30.09	23.05	23.33	24.53	19.47

[1] Relative to 1919=100

Industrial Index Numbers

CONTINUING the section started last month, MANAGEMENT ENGINEERING presents below three additional tables showing the trend of movement in price index numbers, metals and metal products, and transportation. These industrial index numbers were compiled by the Department of Commerce from data collected by various government bureaus, trade associations, and trade journals. As pointed out last month the value of the compilation lies in the bringing together in one place considerable valuable data formerly very widely scattered. In presenting these index numbers the Department gives as its opinion that "to be of value such information must be widely diffused and digested by the business men of the country." It is not enough, the Department declares, "that the banks and big businesses should understand the trends in business, it is essential that the small manufacturer and the dealer should have understanding also." Such ends are greatly to be desired, and it is from this viewpoint that the figures below are given.

TABLE 1. PRICE INDEX NUMBERS

(All figures are based on 1913=100)

Year and Month	Bureau of Labor Statistics											Department of Agriculture		Dun's	Bradstreet's
	Wholesale Prices										Retail Prices of Food	Farm Prices of Crops	Farm Prices of Live-stock	All Commodities	All Commodities
	Farm Products	Food	Clothes and Clothing	Fuel and Lighting	Metals and Metal Products	Building Materials	Chemicals and Drugs	House Furnishing Goods	Miscellaneous	All Commodities					
1920 January	246	253	350	184	177	268	189	324	227	248	201	241	173	205	221
April	246	270	253	213	195	341	212	331	238	268	211	271	181	213	225
July	236	268	317	252	191	333	217	362	243	262	219	304	176	215	210
October	182	204	257	282	184	313	216	371	229	225	198	202	166	196	184
1921 January	136	162	208	228	152	239	182	283	190	177	172	129	120	164	137
February	129	150	198	218	146	222	178	277	180	167	158	123	117	154	134
March	125	150	192	207	139	212	171	275	167	162	156	120	123	150	129
April	115	141	186	199	138	203	168	274	154	154	152	113	112	144	123
May	117	133	181	194	138	202	166	262	151	151	145	104	109	138	117
June	113	132	180	187	132	202	166	250	150	148	144	109	104	137	115
July	115	134	179	184	125	200	163	235	149	148	148	106	—	132	116

TABLE 2. METALS AND METAL PRODUCTS

(All figures are based on 1913=100)

Year and Month	Iron Age	American Iron and Steel Institute	Department of Commerce	U. S. Steel Corporation	Engineering and Mining Journal	N. Y. Metal Exchange	Department of Commerce	Department of Commerce
	Pig Iron Production	Steel Ingot Production	Iron and Steel Exports	Unfilled Orders	Copper Production	U. S. Tin Stocks	Tin Imports, Bars, Blocks, etc.	Zinc Imports, Bars, Blocks, etc.
1920 January	118	118	146	157	90	202	92	50
April	107	105	173	175	86	145	108	193
July	120	111	183	188	81	104	184	54
October	129	120	190	167	78	173	71	43
1921 January	94	87	239	128	67	138	27	26
February	76	69	172	117	64	192	55	107
March	62	62	101	106	67	188	32	197
April	47	48	71	99	35	132	26	175
May	48	50	62	93	19	139	21	—1
June	42	40	47	87	..	138	43	8

TABLE 3. TRANSPORTATION

(All figures are based on 1919=100 except those in the last column, which are based on 1913=100)

Year and Month	American Railway Association										War Dept. Engineers Corps
	Surplus Freight Cars at End of Each Month[1]			Average Car Loading Per Week							
	Box Cars	Coal Cars	Total Cars	Grain and Grain Products	Livestock	Coal	Forest Products	Ore	Mdse. L. C. L.	Total	Saulte Ste. Marie Canal Traffic[2]
1920 January	—1	—1	4	98	110	113	102	26	98	102	—
April	4	2	4	69	79	91	108	43	87	88	5
July	—1	—1	1	87	81	109	103	190	126	109	116
October	2	—1	2	98	102	127	109	201	115	124	130
1921 January	218	120	171	103	96	99	79	24	79	85	—
February	211	229	218	94	86	84	94	24	84	85	—
March	208	337	262	95	79	75	90	18	93	87	—
April	217	303	255	86	82	74	84	15	95	87	10
May	189	218	208	98	81	89	87	63	96	95	62
June	178	215	197	104	83	88	88	78	97	95	81

Minus signs in the above tables (—1) indicates less than one per cent.
[1] Based on average for last week of each month. Does not include Canadian Road.
[2] Canal closed from middle of December to middle of April.

MANAGEMENT ENGINEERING

THE JOURNAL OF PRODUCTION

L. P. ALFORD, *Editor*
E. W. TREE, *Associate Editor*

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The Time-Study Controversy

THE June *Bulletin* of the Taylor Society is devoted to an ingeniously developed symposium on "Stop-Watch Time Study" in the form of an indictment and a defense. The Gilbreths indict and several of the Taylor Co-operators defend. Inasmuch as the majority of the points raised still seem to be at issue because of the absence of facts and quantitative data, it may be assumed that the pleasant controversy will be continued.

Throughout the discussion, it may be remarked, there seems to run a lack of appreciation of perspective. The stop-watch is a measuring device, as is likewise the motion-picture camera when used to time operations in industry. Such operations differ widely. There are those that are repeated millions of times every working day—as in using typewriters; others are seldom repeated—as boring and turning 16-in. gun forgings. Any amount of refinement of apparatus and method in studying to improve the operation of a typewriter is unquestionably justified, while the machining of a gun forging is so simple and the operations of so long duration that the simplest kind of a measuring device is adequate. Some operations must be timed, moreover, to a close fraction of a minute, requiring a device like the motion-picture camera, others can be studied adequately with an ordinary watch or even an 8-day clock.

From another point of view operation studies may be made for several purposes: to improve the performance of the operation, to furnish data for rate setting, or to secure information for job specification.

It is earnestly to be hoped that the discussion so ably begun will be continued until these and other limitations are formulated and accepted. The editor of the matter appearing in the *Bulletin* asks for further evidence, particularly in regard to actual times and costs. Building upon this request, MANAGEMENT ENGINEERING ventures to ask for the answers to the following:

> What are the limitations of application of the stop-watch and the motion-picture camera in time studies? What is the relative accuracy of each device? What factors cannot be recorded by each?

The Gilbreths state that the stop-watch does not record surrounding conditions nor anything regarding the methods of the superexpert or the best demonstrator obtainable. Carl G. Barth says of the micromotion method that even the application of a microscope to the films themselves cannot possibly show the condition of repair of the machine, the correct shapes and settings of the tools, nor the spindle revolutions and the feeds of the machine observed.

Again MANAGEMENT ENGINEERING ventures to ask a question or two:

> What degree of skill is needed to interpret stop-watch observations on the one hand, and the motion-picture films on the other? What is the relative cost in each case of making the observations, and what the cost of their interpretations into a form to be used for improving an operation or process, or determining standard times or setting rates?

It is said of Lord Kelvin that whenever a new project was presented to him his first question was—"How much?" We need to know "how much" in regard to these contrasted devices and methods for operation study.

* * * * * *

The basic criticism of stop-watch time-study made by the Gilbreths is inaccuracy. This is referred to again and again in their indictment and closure. In the early paragraphs of the indictment occurs this statement, the italics being theirs: "Every statistician knows, and to most students of science it would seem almost axiomatic, that *final averages are no more accurate than the data from which they are derived.*" This is supported by two quotations from "Elements of Statistical Method" by Willford I. King. These are: "The total can be no more accurate than its most faulty item," and "The absolute accuracy of a total can be no greater than that of the most inaccurate item composing it." That is, a statement in regard to the inaccuracy of final *averages* is supported by quotations concerning the accuracy of *totals*.

If the authors had read further into the section of King's book from which the second sentence is taken, they would have discovered this comment: "This fact that the probable error of the average of a number of items is less than that of any single item is of great value in scientific work." And again, "Even the personal bias of the observers tends to be eliminated by the averaging process." The relation between the possible and the probable error in an average is also given in this same section: "*Hence, the possible error of an arithmetic average is equal to the average possible error of the items in the series.* In obtaining this possible error, we assumed that all the errors were in a similar direction. As a matter of fact, however, the chances that this will be true are very remote when the number of items is large and the errors are of the compensating type. The *probable* error of the arithmetic average is therefore only a fraction of the possible error. If $E =$ the possible error of the arithmetic average, the probable error of the same is approximately $E/\sqrt{n}$." (n is the number of items.)

Final averages are probably therefore not so inaccurate as the indicters of stop-watch time-study would lead us generally to believe.

Managing Versus Borrowing

"THERE are ways of meeting financial obligations other than borrowing money." This nugget of business wisdom was thrown to us by Henry Ford in an interview published in *The Detroit News* of July 22. In the course of the story the great manufacturer revealed his strategy and the powerful and decisive action with which he met and overcame a difficult financial situation.

The broad facts are these: Mr. Ford had obligations between January 1 and April 15 amounting to $58,000,000. He had but $20,000,000 available in cash. Bankers believed that he could not secure the additional $38,000,000 needed and proceeded to offer a loan. One of these gentlemen actually reached Mr. Ford with his proposition, but at the end of twenty minutes he was summarily shown the door. This was in late January. Before April 1, Mr. Ford had $87,300,000 ready in cash with which to meet $58,000,000 in obligations.

It is evident that Mr. Ford foresaw something—a great possibility.

This something is revealed by relating what Mr. Ford did. Briefly put, he liquidated, economized, and eliminated waste. In more detail, between January 1 and April 1 he converted $24,700,000 of material into cash. He released $28,000,000 tied up at the beginning of this period in stock in transit. He collected $3,000,000 from foreign agencies, sold by-products to the amount of $3,700,000 and Liberty Bonds to the extent of $7,900,000. These sums plus the $20,000,000 held in cash at the beginning of the period give the total of $87,300,000.

Something of the way by which this was achieved is shown in these facts: The period of material turnover, that is, the length of time required for the movement of stock from the supplier of raw materials through the factories into assembled cars and into the hands of the dealers was shortened from 22 to 14 days. This reduction of the material turnover period permitted a cut in the investment in reserve stock and stock-in-process from $88,000,000 to $60,000,000. The former sum was required to meet a production schedule of 93,000 cars a month. The smaller sum now suffices for a schedule of 114,210 cars per month. The office force was reduced from 1,074 to 528 persons. Telephone extensions were cut 60 per cent. Foremen were put on machines, so that now there is one for every twenty men where formerly there was one for every three to five men. In November, 1920, the labor and commercial overhead charges per car were $146; in June, 1921, this had been reduced to $93. Formerly fifteen men were employed per car produced per day, now but nine are required.

These facts all trend in one direction—downward to a sound, economic basis of manufacturing. They were brought about by stern readjustments, by good management. The possibility of meeting financial obligations through good management instead of borrowing money is what not one in a thousand of us can see.

Engineering as an Art

IN the past few years, the technical press and the transactions of engineering societies have been filled with questioning as to why professional engineers receive such low remuneration. There has been much complaint that industrial executives are not more often chosen to head large enterprises instead of men from the financial and commercial branches of business. There is a national movement to make known the right of the engineer to leadership.

The statement is ventured here that the trouble is with the technical man and not with the unappreciative world. Nor will the trouble be corrected until the great majority of engineers take a radically different view of their profession and realize clearly the kind of personal development that is necessary to attain the possibilities they hope for.

How can leadership be developed? The answer is reiterated with singular aptness by all the great leaders in military affairs who have organized and controlled human effort on a stupendous scale. Napoleon, of still uneclipsed genius, wrote, "One may teach tactics, military engineering, artillery work, about as one teaches arithmetic or geometry. But knowledge of generalship is acquired only by experience and studying the history of the wars of great generals. It is not in the grammar that one learns to compose a great poem." "Military art is a life-long study," says Colonel Dodge, one of the best known American critics. Von Moltke, father of modern armies, puts it, "There must be a development of mind and character, guided . . . by the experience of military history." "War experience alone is no school," concludes the great Foch, "by studying the achievements of great leaders the principles are learned."

Engineers will not grow to the caliber of industrial generals until they deliberately study generalship. Only in the careers of the great industrial leaders can the higher strategy be studied. From now on let us look on engineering, not as we do at present, to be taught "like arithmetic or geometry," but as requiring in addition to the grammar of technological training, a constant discriminating search for the subtler facts revealed by the successes and failures of policies and plans.

Such material is on every hand—in the published decisions of the courts, reports of commissions, biographies of great executives, the balance-sheets of Poor's Manuals, works on economics. From such sources, as well as personal experience, must the art of leadership be acquired. "There is no studying on the battlefield," says Foch; and it is likewise true that few minds can connect widely separated causes and effects in the rush of daily business. But by studying the careers of enterprises and individuals, examining conditions under which decisions were made, and tracing the results, perhaps years later, of these decisions, one begins to think in broad principles of human action. And by consciously applying the lessons in the affairs of his every day life he may grow to be a leader of men.

BOOK REVIEWS

Industrial leadership *658.372*

THE MANAGEMENT OF MEN

By Edward L. Munson
Publisher, Henry Holt and Company, New York

REVIEWED BY EDWARD EYRE HUNT

A BOOK which gathers up and makes accessible the American army's war time experience with morale work has value for industry, but the title of the present work, "Management of Men," is too inclusive. Colonel Munson's volume is a book of reference for the army officer, dealing primarily with the problems of training and leading troops. But it deals with these problems from a standpoint so liberal and from an experience so rich and varied that the industrial manager who has the patience to read this compact volume of 775 pages will find much that is new and much that applies directly to his problems. The arrangement of the material will not help him; he must dig out the nuggets himself. To that extent the book's title, and the subtitle—"A Handbook on the Control of Human Behavior with Special Reference to Man-power in Industry"—are misleading.

I had the pleasure of reading Colonel Munson's volume in manuscript and recommended its publication. My criticism, therefore, is not intended to be hostile. The book as published is a mine of information, clearly and simply written, adequately illustrated, sure to stir up comment. Considered only in their application to industry, Colonel Munson's suggestions frequently give a new twist to one's thinking. He writes:

> The morale problems in an army are restricted in variety as compared with those of civil life, by reason of unity of purpose, limitations of class through sex, age, and selection, more or less standardization of environment, and a single code for the government of conduct. This, however, does not mean that the morale problems of industrial life, by reason of their greater diversity and complexity, will not be similarly responsible to intelligent methods of control.

These methods he outlines in relation to the army and suggests in relation to industry, but their application is dependent on an assumption of responsibility by management; a recognition of the fact that leaders must lead, not merely command. "Co-operation," he says, "is better than compulsion"—an aphorism which should rank with Cavour's remark that "any fool can govern by martial law."

The duty of management as Colonel Munson conceives it—he was responsible for morale work among war time industrial workers as well as among the troops, and thus speaks from knowledge—is to manage morale just as skilfully as it manages the material elements of industry. The purpose of the entire volume is to indicate the responsibilities and opportunities of leadership, military or civil.

> There are good managers of men in civil life just as there are good leaders in the military service—men who by natural ability and experience possess a high degree of leadership. But the proportion is relatively small; probably much smaller in civil life than in the military service, where one of the essential qualifications of officers is the ability to exercise a fair degree of human control.

The industrial manager who is more interested in doing his duty than in shifting responsibility for his failures to the shoulders of the rank and file, will find much to hearten as well as enlighten him in Colonel Munson's pages, and if such a manager also happened to serve with the armed forces of the United States in the recent war, the book will have a double message for him.

Cost accounting *657.524*

COST ACCOUNTING TO AID PRODUCTION

By G. Charter Harrison
Publisher, The Engineering Magazine Company, New York

REVIEWED BY G. W. GREENWOOD

THIS book should be of decided value to the executive who, to eliminate waste in manufacturing, must first discover it; to the accountant wishing to rise from a mere historian into the ranks of those charting the future course of the company; to the sales manager needing a satisfactory basis for pricing products; and to the operating superintendent desiring exoneration from expenses outside of his control.

To readers of the writings of Taylor, Emerson, Gantt, and others of like caliber, arguments in favor of standards are well known. But in accounting one needs such a work as the present in order to measure performance against the standards so set, and to allocate properly the difference.

The book emphasizes "predetermined" costs and abounds in convincing arguments in their favor, as opposed to current post-mortem cost finding. For example, consider how the velocity of light was discovered by predetermining the eclipses of Jupiter's moons, finding that apparently they did not occur on scheduled time, and how similar predetermination of events has led to other valuable discoveries—discoveries which in all probability could never have been made from mere historical compilations of results—and then one may realize that in predeterminations along commercial lines lies the highway to profitable knowledge.

In the early part of the book we read:

> . . . in the business of today a cost system that does not provide for predetermination of costs cannot be regarded as in any way meeting requirements . . . it should be possible for the cost accountant to furnish an approximately accurate cost of any machine under current conditions in less than half an hour after the information is called for, and this should be so even if the machine in question comprises several hundred parts and necessitates the performance of five times as many operations.

The value of information relative to the cost of manufacturing operations is generally in direct ratio to the promptness with which such information is furnished.

Contrast this with so-called cost figures which are not completed until weeks, perhaps months, later, and which are used more as an alibi for high operating charges than as a guide to the future.

By methods outlined one can compare operating charges and efficiencies of one period with those of another, ascertaining satisfactorily which differences are due to conditions beyond the control of the management and which differences can be, and should be, controlled.

Of particular import under present operating conditions are the methods of separating the cost of idleness from that of manufacturing, any system of cost accounting which includes idle costs in its manufacturing costs being for all practical purposes useless and misleading. But should not standard costs contain a reserve for idleness?

The subject of overhead, or burden, is handled in a gratifying manner. Too frequently works on accounting when treating this subject become indefinite, implying that there is a scientific method of distributing this expense if only the author were free to reveal the process. In contrast with this we read:

The exercise of the faculty of judgment is of particular importance when determining methods to be employed in connection with burden distribution.

The question of burden and its proper treatment is one about which more opinion and degrees and variation of opinion exist than perhaps in connection with any other accounting principle, and one upon which there are almost as many authorities as beliefs.

Prominent among these is the prevalent misconception of refinement of distribution for accuracy of disposition.

It is the reviewer's opinion that an accountant, if he so desires, can begin applying, a step at a time, many of the methods outlined in this book. He may, without disturbing his present accounting system, set down in a column the operating charges for any particular month, and by their side the charges based on some standard determined upon, computing the differences and endeavoring to account for them. And in making such a preliminary application, he will be encouraged to go farther.

Industrial leadership *658.372*

INDUSTRIAL LEADERSHIP

Proceedings of the Spring (1921) National Convention of the Society of Industrial Engineers

THE proceedings of the Society of Industrial Engineers are always presented in a convenient and usable form. Each convention, spring and fall, is devoted to one major topic, and the papers and discussions are grouped in a bound volume to which many have contributed of their best.

The issue under review is well up to standard. Some sixty men and women took part in the convention, and contributed to the proceedings either through professional papers, addresses, comments at group meetings, or discussions. The general topic "Industrial Leadership," was held to from start to finish, the only digressions being in the professional group meetings, which were devoted to restricted technical matters.

The first three addresses gave the fundamentals of leadership in industry from somewhat different points of view, and taken together sounded the keynote for all that followed.

L. W. Wallace, the president of the Society, touched more particularly upon the responsibilities of the industrial leader, and summarized these under seven heads, counseling his hearers to undertake these activities:

Apply the experience of honesty, of courage, of common sense to the manifold [industrial] problems.

Adopt and adhere to the principles of publicity.

Know the economic facts and give them to the employee and to the public.

Devote time and effort to matters of community, state, and national concern. From your treasure house of splendid training, ripe experience, and accumulated knowledge, give needed values to community, to state, and to nation.

Remove from industry many restrictions and burdens imposed by legislation and board control. A greater statesmanship is needed in our legislative bodies. It is the responsibility of the industrial leader to interest himself as an intelligent citizen in securing such statesmanship.

Advance broad-minded and constructive co-operation and suppress violent competition.

Give Congress your support, the value of your experience, and your effort, to the end that the federal government may become the best organized and managed government of the world.

Stimulate and support a movement whereby there may come about a greater standardization and stabilization of industry, the two factors which must contribute most largely to industrial economy.

Harrington Emerson presented four qualities pertaining to industrial leadership. The first he declared to be character, that quality which brings dependability; the second, competence, which has always been necessary in any kind of leadership; the third, the great quality of courage, of energy, and of initiative; the fourth, the quality of charm or tact.

Commenting upon the last, Mr. Emerson said: "You may have character, you may have competence, you may have courage, but if you do not have the ability to make other people willing to follow you, it is all for no purpose."

Edward T. Miller also presented four qualities of leadership, arranging them in two groups. In the first he declared that leadership is prospective, not retrospective, and attractive, not repellent. In the second, he stated that leadership is constructive rather than destructive, and that it is always operative; that is, it maintains and operates what has been previously planned and constructed.

Fall Convention of Industrial Engineers

THE program for the fall convention of the Society of Industrial Engineers to be held in Springfield, Mass., October 5 to 7, inclusive, has been announced. The major topic is to be "The Influence of Distribution upon Production" and the plan used at the last convention at Milwaukee, whereby members interested

in particular topics met in small group meetings, is to be followed. The first four of these deal with Accounting, Industrial Relations, Production, and Sales.

The first general session is to be devoted to Industrial Stability, with L. W. Wallace, president of the Society, and F. M. Feiker, assistant to the Secretary of Commerce, as speakers. The following general session is devoted to Sales, Sales Standards, and Co-operation between the Sales and Factory Organizations. E. St. Elmo Lewis, Norval A. Hawkins, and Frank L. Willis are to be the speakers. The third general session is devoted to Standardization of Materials and Labor, and the Co-ordination of Sales and Financial Policies, with Arthur T. Davenport, Harry A. Hopf, and the Hon. James J. Davis, Secretary of Labor as the speakers.

The first general session of the final day is to be devoted to the Elimination of Waste in Industry through Standardization, in the nature of three one-hour discussions. Robert B. Wolff, L. P. Alford, and F. B. Gilbreth have been selected as the chairmen. The close of the convention is to be a banquet with three addresses dealing with aspects of industrial stability, namely, "Influence of Foreign Trade," "Education of the Public," and "Relation of Government."

Throughout the convention an opportunity will be offered during the mornings to visit representative plants in Springfield. Also again following the plan carried through at Milwaukee, there will be an exhibition of charts, particularly in relation to management and education.

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René Descartes

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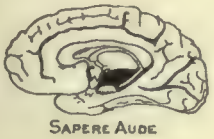

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The Organization of Knitting Mills

Solving the Problems of a Specialized Industry

By CARLE M. BIGELOW

Chief Engineer, Cooley and Marvin Company

THE first knitting machine was made in the year 1589 by Rev. William Lee, curate of Calverton, in Nottinghamshire, who together with local craftsmen developed a machine known as the knitting frame and which produced a complete knitted fabric. The power of this knitting machine was of course manual. This knitting frame was improved in 1620 by Aston, an apprentice of Lee, and together with James Lee, a brother of William Lee, Aston built many frames with the result that by 1640 stocking making had become a staple industry in Nottinghamshire, Leicestershire and Derbyshire. By 1727 it is estimated that there were 8,000 frames at work in England.

In 1758, Jedediah Strutt invented a ribbing attachment which by improving the elasticity of the fabric increased the value of the product immensely. The next invention was that of Crane in 1775, who produced the first warp knitting, the development of which was further improved by Tarratt of Nottingham shortly afterwards. In 1786 the making of fleecy hosiery fabric was introduced, the forerunner of our present fleece-lined garments.

THE FIRST CIRCULAR KNITTING MACHINES

All of the above knitting was flat knitting. Actually the first circular machine to be developed was by Decroix in France in 1798. The first practical development, however, of the present tubular machine was made in 1816 by Sir Marc I. Brunel, whose invention in turn was improved by Peter Claussen in 1845. In 1857 Luke Barton built a frame with a mechanically controlled narrowing mechanism, the first step in the development of the present automatic machine. Finally, the development of the tumbler or latch needle by M. Townsend in 1858 may be said to conclude the early development of the industry. From that time on the various types of knitting machines have been continually improved until the present wonderful equipment of the automatic machine was developed.

Looking into the future, it would appear that no branch of the textile industry has such brilliant prospects as knitting. When we realize that with practically two operations yarn can be converted into a fabric by the knitting process, while the weaving process requires many more steps, it appears that should it be possible to turn out firm, stout fabrics by knitting this industry will gradually become the fabric producer. Even now a large amount of women's wear and a considerable volume of splendid sporting and overcoat fabrics for men are being produced by knitting. In fact there is hardly an article of clothing today some form of which has not been prepared by the knitting processes. It would seem, therefore, that the knitting industry as a whole has a splendid future.

THE ORGANIZATION OF A KNITTING MILL

A knitting business may consist of many combinations of the industry. In complete form it may consist of the preparation and spinning of yarn from raw stock, the winding and knitting of this yarn into a knit fabric from which underwear or garments may be cut and finished, or hosiery directly knit, together with all of the necessary finishing operations. Again, yarn may be purchased from the outside and merely wound and knit into the required fabric, and then cut and finished into garments; or the industry may consist merely of the winding and knitting of the yarn into tubular gray fabric which is sent to an outside plant for dyeing and finishing. Because of the wide divergency of the character of the work performed in a plant which operates from the raw material to the finished product, the organization is usually found to be complicated and indirect, especially so in a concern which manufactures both hosiery and underwear.

For example, the preparation and manufacture of yarn is a division in itself. Next, the knitting of fabric for underwear is entirely distinct from the knitting of yarn directly into hosiery, and the complicated sewing

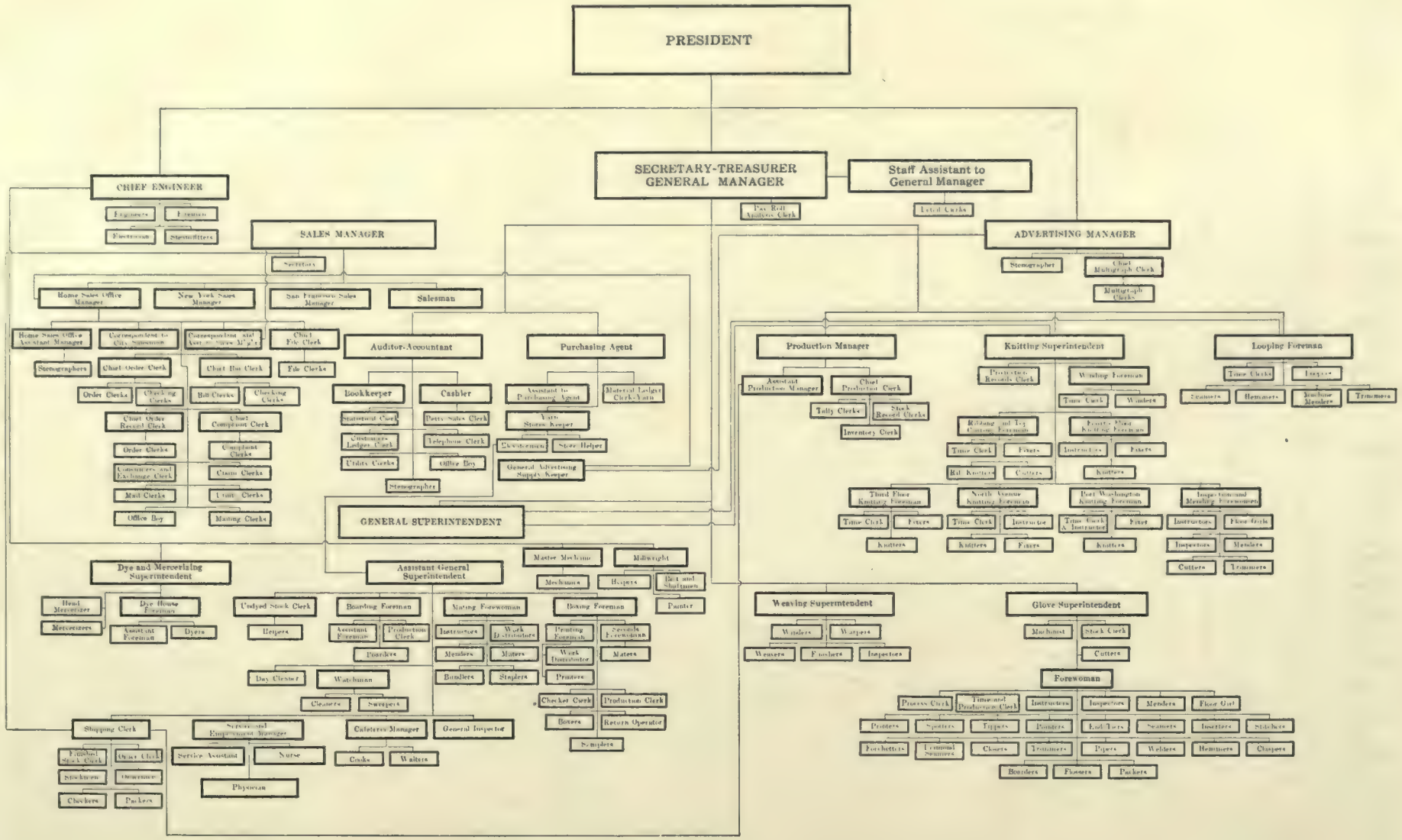

FIG. 1 THE ORGANIZATION CHART OF A TYPICAL KNITTING MILL

operations required to finish underwear differ entirely from the finishing operations on hosiery. In each of these fundamental divisions there will usually be found an individual who is more or less an authority responsible only to the general manager. Sometimes a general superintendent is employed, but very rarely does such an individual have charge of all of the various divisions of the industry.

VARYING PRACTICE IN HANDLING SALES AND ORDERS

Again a wide divergency of practice is found in the handling of the sales and orders. Some knitting plants market their own product, maintaining their own selling organization, while others sell to jobbers wholly or may dispose of their goods through a selling corporation organized entirely separate from the manufacturing end. Whether a concern merchandises its own goods or not is vital in its effect upon the method of handling orders. When a complete sales organization is maintained, it is usually found expedient to have this organization handle the orders as received and to prepare manufacturing budgets with, of course, the necessary co-operation and advice as to manufacturing economies from the production department. When, however, a selling organization does not exist, the analysis and preparation of orders can best be handled in the planning or production department.

Furthermore, when the product is sold by outside agents and the planning department controls the orders and production, purchasing and material control should also be handled directly by the planning department, for the reason that in the development of the method of stock control the flow of orders is the guide upon which the stock control is based, and with this information directly at hand the material requirements can be determined and the purchases made and expedited. When, however, the selling organization is maintained locally and definite budgets of production and materials can be prepared well ahead, a separate purchasing and stores control is advisable.

To an individual not familiar with the great multiplicity of details in the knitting industry the above distinctions may not be entirely evident, but when it is considered that in a hosiery mill, for instance, the units of manufacture have a value of a comparatively few cents and that hundreds of thousands of units of various sizes, colors, packings, etc., are required to make up a year's manufacturing quota, the requirements become more evident. For instance, a machine tool plant shipping 500 units a year might have gross sales far in excess of a hosiery plant which manufactures several hundred thousand units a year. Therefore the preparation of production budgets, material budgets, etc., is an intricate problem requiring controls of extreme flexibility.

Where a concern markets its own product it can to some extent prepare such budgets in advance and influence sales somewhat in accordance with manufacturing capacity. But when an outside organization is marketing the product to a large extent, the factory must be sufficiently flexible to take care of practically any assortments of orders entered. For this reason where the sales organization exists and budgets can be prepared, order, purchasing, and stock control can be functionalized separately from production, but where the factory must be ready to operate in practically direct accordance with fluctuating sales requirements controlled entirely by an outside organization, the order and stock control, purchasing, etc., must be combined with the production and planning control.

Another fundamental difference of the knitting industry from many others is the usual absence of such an individual as a plant engineer and the small amount of attention devoted to maintenance. The majority of equipment in a knitting plant is of a light, delicate nature such as knitting machines, sewing machines, etc., and is maintained by departmental fixers directly under the control of the departmental foremen. This is advisable inasmuch as production and the mechanical condition of the equipment bear such a close relation. In a knitting plant, therefore, plant maintenance, etc., receives little attention. So far as power plant control is required, this is also comparatively simple inasmuch as usually the power is purchased electrical energy in conjunction with a local heating plant.

A TYPICAL KNITTING MILL ORGANIZATION

A typical organization of a knitting industry as found before scientific management has been introduced is shown in Fig. 1; this particular industry purchasing its yarn but carrying on its own dyeing and mercerizing, knitting of hosiery, weaving of glove-cloth fabric and finishing of the final hosiery and glove product. It will be noted that the lines of authority are very much confused and that an entire lack of balanced authority exists. Fig. 2 shows the same organization revamped along systematic lines with the introduction of three management committees.

The complexity in the problems of a knitting plant of the magnitude illustrated is so great that to show the real relations of the departments and their operations an ordinary organization chart is usually found ineffectual. For this reason, it has been the author's practice to prepare a control chart such as that shown in Fig. 3, which illustrates the general traveling of the records and the relation of the various methods of production and cost control.

It will be noted in Fig. 2 that the organization maintains its own sales department and that the orders are controlled by the sales department, in this case there being no relation between the order function and the planning, as the production was based fundamentally upon budgets rather than upon co-ordinated effort between the two. It should also be noted that instruction departments are maintained in both hosiery and glove departments, closely co-ordinated in both cases with the service department. As mentioned the matter of instruction and social service is here very essential.

Fig. 4 shows a much simpler organization in a plant which does not maintain its own selling organization but manufactures its own yarn as well as knitting and completely finishing both hosiery and underwear. It

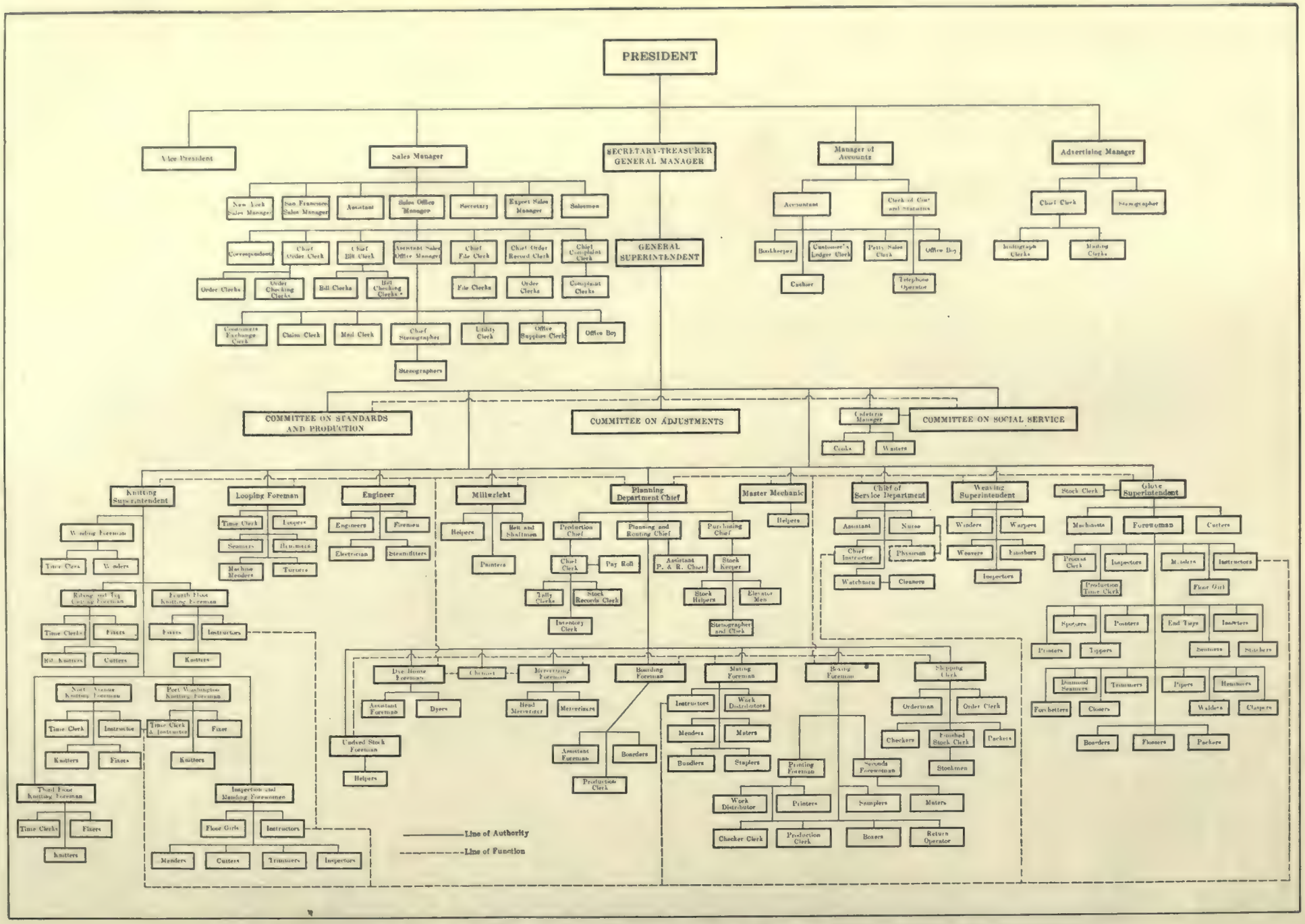

FIG. 2 THE ORGANIZATION CHART OF A KNITTING MILL CONDUCTED UNDER THE DIRECTION OF THREE MANAGEMENT COMMITTEES

should also be noted that this organization does not provide for instruction or service work, for the reason that this installation was made in a foreign country where a constant supply of skilled labor was available.

When the type of organization has been definitely laid out and approved the installing engineer must clearly provide for the systematic use of written instructions before he attempts to instruct the personnel in their new duties. To illustrate the use of these, the following set of instructions is given, which the author has frequently used.

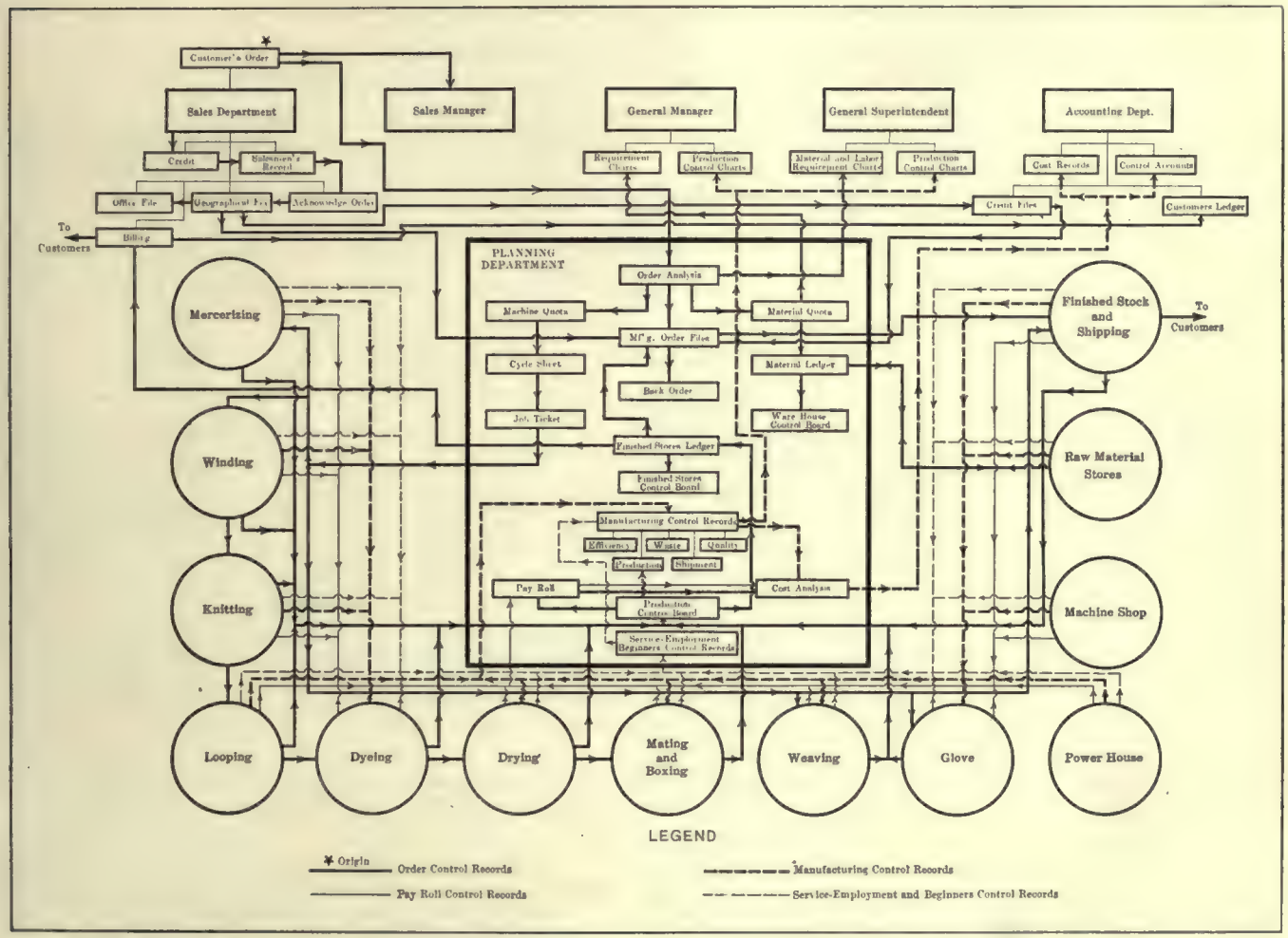

FIG. 3 CONTROL CHART FOR A KNITTING MILL SHOWING THE GENERAL LINE OF TRAVEL OF RECORDS AND THE RELATION OF THE VARIOUS METHODS OF PRODUCTION AND COST CONTROL

HOW TO WRITE AND USE GENERAL INSTRUCTIONS

Broadly speaking, there are two methods that may be followed in instituting any standard practice. One is to depend upon verbal instructions; the other, upon written instructions. The former, especially in the form of conferences of heads of departments, is of the greatest help in securing the co-operation of those who will be called upon to execute the details of the new practice and in serving to explain its advantages and clear up misunderstandings. Such conferences will do much toward offsetting the impersonal character of an order in writing.

To be lastingly effective, however, personal instructions should be backed up by written instructions, referred to here as general instructions or simply instructions. Verbal instructions are more easily forgotten, disregarded, or misunderstood than orders in writing and do not carry the same weight as a typewritten standard practice instruction signed by some official of the company. Moreover, in personal instructions there is much greater liability of overlooking some important detail.

The policy of avoiding verbal orders is not, however, all that is necessary. That full benefit may be derived from standard practice instructions there should be established some regular procedure providing for their preparation, approval, and issuance, otherwise there is danger that foremen and heads of departments will find themselves swamped with a great quantity of written orders, instructions, routines, etc., issued by different persons, sometimes contradictory, often changed, and not in accordance with any uniform or well-considered system. Under these conditions, it is no wonder if officials or foremen hesitate before looking through their mass of papers whenever any unfamiliar situation arises.

The plan used should have the following features:

1. The preparation of the standard instructions. This work should be delegated to one or more persons who are in a position to issue these instructions covering certain phases of shop work, such as the head of the Planning Department in preparing standard instructions as to how certain forms should be made out by the factory foremen in order to give the proper information needed by the Planning Department. The head of the Design Department might be delegated to prepare standard instructions covering the design of any particular part of the product. The writing of these instructions will also be to a considerable extent part of the work of the General Manager. Regardless of who issues these instructions they should be O K'd and signed by the General Manager before they are sent out.

2. The instructions should be prepared on standard size sheets with headings showing the subjects, the instruction number, and the date of issue.

However, the general manager's instruction book should contain a copy of each instruction issued, filed by departments.

CLASSIFICATION OF SUBJECTS UNDER WHICH ALL INSTRUCTIONS SHOULD BE ISSUED

A—Policy
B—Rules and Regulations
C—Hiring, Handling, Training, and Discharging Personnel
D—Design and Standardization of Products
E—Inspection
F—Organization
G—Preparation and Operation of Forms
H—Machines and Their Maintenance
J—Maintenance General
K—Motion, Time Study and Rate Setting
L—Purchasing, Receiving, Storing, Issuing, and Packing

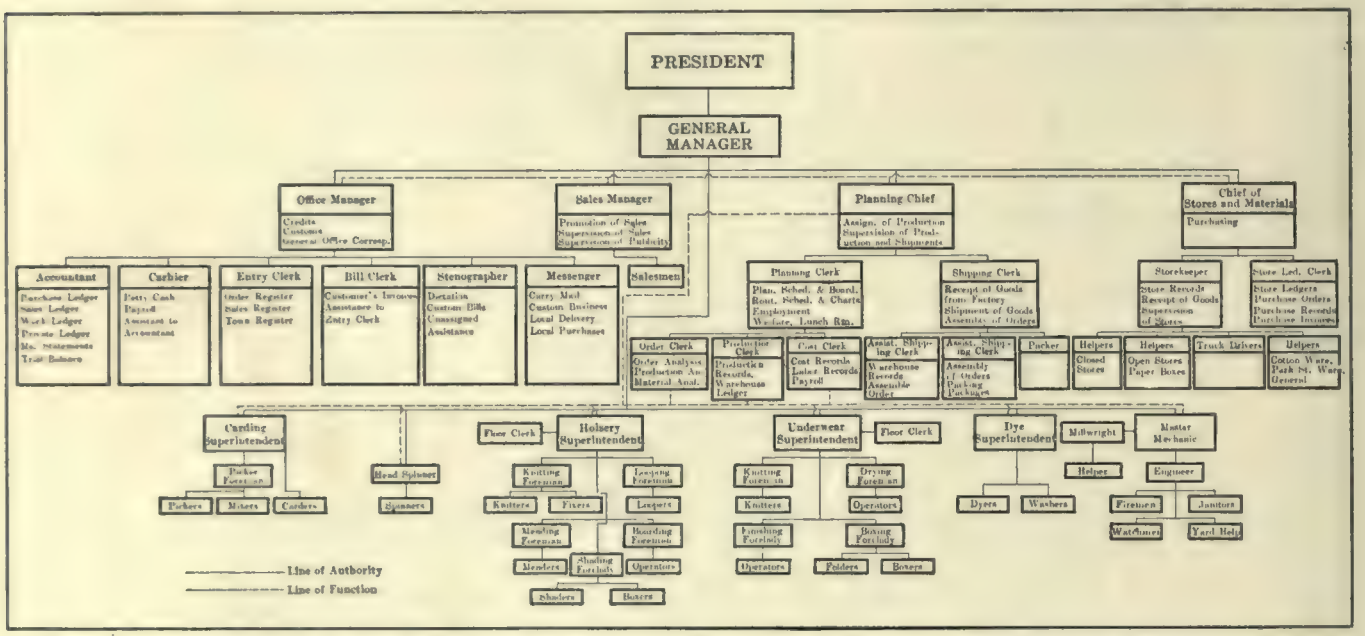

FIG. 4 ORGANIZATION CHART OF A KNITTING MILL WHICH DOES NOT MAINTAIN ITS OWN SELLING ORGANIZATION

3. A system of classified subjects should be outlined under which all instructions should come.

4. No details of any importance should be omitted when writing up these instructions, and they should be kept strictly up to date by revision and additions.

5. The standard instruction book should be kept in some particular place in each official's or foreman's desk where it will always be handy for reference and easily found when new instructions are to be inserted. This instruction book, moreover, should be some suitable form of the loose-leaf type so that instructions may be easily inserted and kept under their proper heading.

6. The actual issuance of instructions and their insertion in the various departmental books should be executed by one individual only, acting under direct authority of the General Manager.

7. Whenever a general instruction is issued which supersedes another, it should be entitled—General Instruction No. ....., Superseding Instruction No. ....., and across the face of the first page of the instruction superseded there should be written in ink by the person inserting the new instruction the following: Superseded by Instruction No. ..... on (Date) ..... (Name) .....

8. At the bottom of each instruction should be the name of the officer or department to which the same instruction has been issued. This will enable the executive to know whether or not he may count on some other department head being familiar with its contents. Only such instructions as concern a particular department should be placed in a departmental instruction book.

When any instructions are sent out they should be taken to the various departments to which they have been issued and inserted in the proper place in the instruction book. This must be done by the person who delivers the instructions and not left to the foreman. After the instruction has been placed in the book the foreman must be notified and his signature secured by having him place his initials after the notation of his department on the general manager's copy of the instruction. This will show that the instruction has been properly delivered and help to create a great sense of responsibility on the part of the foreman for seeing that its provisions are carried out. Anyone who has signed a receipt for an instruction is strictly responsible thereafter if he fails to comply with the instructions.

Such instructions as these greatly simplify the task of breaking in new men. The time and expense required for their writing and issuing are regained many times over, for the instructions do away with a vast amount of wasted effort spent in giving special directions and in doing things wrong.

Experience has shown that no part of this plan is impractical. The business which has all its departments written up in this way possesses a record describing the procedure to be followed on every kind of routine work. Furthermore, the scheme of classification and indexing makes it possible to find at once any desired information.

Power plants. Management
Fuel economy
Industrial waste

621.311 : 658
662.621
62(0048)

The Economic Operation of Small Power Plants

How to Reduce the Wastage of Coal, Steam, Water, Electric Power, and Compressed Air

By MALCOLM C. W. TOMLINSON

Consulting Engineer

WHEN the recent report of the Special Committee of the American Engineering Council placed the responsibility for much loss in industry directly upon management, great and general surprise was expressed; and yet it is safe to say that the experience of engineers who have disinterestedly investigated our factories will fully bear out the truth of the committee's finding. In regard to materials alone notwithstanding warnings from many sources on the importance of checking waste in the use of coal, gas, gasoline, fuel oil, wood, and many other natural products which are rapidly diminishing, management has done little or nothing.

Calling attention to the enormous wastage of our coal resources G. O. Smith, Director of the U. S. Geological Survey, has stated that most small power plants consume eight times as much coal per kilowatt-hour as the best central stations. He points out the following amazing per cent coal losses:

In boiler stacks	35 per cent
By radiation	4 " "
In boiler ashes	4 " "
Converting heat into mechanical energy	51 " "
Total	94 per cent

In other words only 6 per cent of the coal distributed is actually converted into energy and the balance is loss. At the same time the National Board of Fire Underwriters reported a loss of $450,000,000 for 5 years due to fires which were strictly preventable. Whatever the reasons behind these losses there is no question of the existence of the losses themselves.

No doubt there are a large number of factory managers who have an earnest desire to reduce or eliminate fuel wastage in their plants, but they are puzzled as to the best method of approach. With such a situation in mind this article will discuss the economic side of the problem, give examples of waste elimination in use of water-, steam-, electric-power, and compressed air, and outline a procedure for such elimination by the use of records and analysis of equipment needs.

TABLE 1. LOSSES DISCOVERED IN SIX INDUSTRIAL POWER PLANTS

Item	Boilers				Tons Coal Per Year		Cause For Wastage
	No.	Hp.	Type	Grates	Consumed	Wasted	
1	2	150	Return Tubular	1—Stationary 1—Shaking	1600	630	Gases passing up stack from fire-box through holes in front arch. Infrequent firing.
2	1	80	Cast iron	Shaking	150	25	Loose fitting sash, window frames, and doors.
3	2	85	Return Tubular	Stationary	1040	200	Engine adjustment.
						100	Wet tank bark fuel.
						90	Extra lineshaft load which ball bearings would eliminate.
						100	No insulation on pipes and boiler drums.
4	1	100	Water-tube	Stationary	800	140	Door and window leakage.
	1	31	Cast iron	Shaking			
	1	69	Cast iron	Shaking		40	No pipe insulation.
	2	73	Cast iron	Shaking		130	Improper firing.
5	1	275	Water-tube	Shaking	3300	330	Simple expansion engine.
	2	200	Water-tube			775	Hand firing.
						200	No insulation on boilers and drums.
6	10	150	Water-tube	Shaking			Carrying 250 kw. load on engine which should have been carried on low pressure turbine.
	1	508	Water-tube	Stoker	22000	1575	

To speak frankly, waste is due to neglect. Carelessness, ignorance, or the fear of change are responsible for the continuation of old, and the growth of new leaks, and until this is fully realized and an earnest desire for improvement is had, betterment of conditions cannot be expected.

Leaks are reduced or eliminated either by a change in methods with little or no expense, by repairs, or by the purchase of new equipment. Expenditures for repairs or additional machinery are not justified unless they will bring at least an equal return. This fact is fundamental and should be the gage by which all improvements under consideration are measured. One conservative corporation demands a full return inside of two years in order to safeguard itself against shutdowns, strikes, business depressions, etc., but a large percentage of our factories would place themselves on a vastly better basis if returns were secured inside of five years. As replacements or additions to equipment thus require careful analysis the factors which must be considered need to be understood.

The true life of any equipment can not exceed its

obsolescence, inadequacy, and uselessness. Large, slow-moving machinery is often purchased or operated long after more economical equipment has come into general use. Although some cases require technical knowledge to determine their limit of usefulness, there can be no doubt as to the obsolescence of the simple expansion steam engine in large sizes and of certain other equipments whose economy is poor.

BOTH QUALITY AND SERVICE MUST BE CONSIDERED

In addition to the original cost, quality and service must also be considered if yearly upkeep is to be kept within reasonable limits. Service alone embraces maintenance, attendance, materials consumed such as fuel, lubricants, repairs, and materials which must be carried in stock, sale of product, and its distribution. Quality plus service determines the rate of depreciation which must be charged off yearly.

Taxes, interest on investment, and fire insurance are large factors in the analysis. As insurance against fire is a subject little understood it might be well to point out that the risk includes buildings, contents, and exposure from surrounding property; that so-called "fire-proof" construction only affords better resistance to the spread of fire and does not eliminate the necessity for insurance, that destruction by fire is largely a question of temperatures, and that the reduction in rates secured by fire-resisting construction is well worth the additional investment.

Finally, basic data on loads and operating conditions, which can only be obtained from operating records and daily logs, must be assembled and reviewed intelligently. Where this information has not been secured recourse must be had to extensive tests or to pure guesses based on conditions in other plants. The size, type, and number of units required depend on these data. A considerable reduction in first cost will usually be effected where the guess, and its factor of safety, are eliminated. It is here that one of the many advantages afforded by the use of a log in boiler- and engine-rooms is found.

After the factory has started operations there are only three methods by which waste in the use of water, steam, electric power, and compressed air can be detected. The first is by means of such records as are kept in accounting or cost departments; the second by the use of the daily log and engineering investigations or surveys and, the third is by actual tests. As the accountant lacks engineering training many data which could easily be obtained are overlooked and many bad leaks are thus allowed to continue. The best method of approach depends on local conditions and should be determined by the engineer.

The necessary mechanical operation records in any factory are few and require little work to secure or keep. Having seen above their value in the selection of equipment, let us note what further uses they serve. The object in keeping records is to furnish data from which comparisons can be obtained, improvements in economy of operation worked out, and future operations predicted. As most factories entrust the collection and tabulation of all records to the cost or accounting department, as the accumulation of data for no particular purpose is waste of time and money, and as the accountant does not possess sufficient technical knowledge to make full use of data on quantity production and distribution, the only record kept in most plants is the number of tons of coal purchased monthly. In factories where the value of records is

Engineering Department
BOILER ROOM LOG

Observer _____ Date _____

Hour	No. 1 Boiler		No. 2 Boiler		Feedwater		Steam	
	Draft in.	Pressure lb.	Draft in.	Pressure lb.	Metered lb.	Temp. deg. fahr.	Metered lb.	Temp. deg. fahr.
6 A.M.								
7								
8								
9								
10								
11								
12								
1 P.M.								
2								
3								
4								
5								
Totals								
6 P.M.								
7								
8								
9								
10								
11								
12								
1 A.M.								
2								
3								
4								
5								
Totals								

Make up water reading _____ 6 A.M.
_____ 6 P.M.
6 A.M.

FIG. 1 A TYPICAL FORM FOR A BOILER-ROOM LOG FOR A SMALL PLANT

The object in drawing up this typical log for a small plant has been to obtain only that information which was essential. As a matter of fact the two items under the heading "Steam" can be dispensed with if a feedwater meter has been installed. As the operation of pumps, conveyors, coal crusher, blowers, and stoker drives depends on the operation of the boilers, typical combinations of equipment should be made up so that the steam, water, and electrical power consumption of the boiler-room auxiliaries can be figured for each day. The calculations mentioned, once made, can be used monthly to figure the total consumption of the boiler-room, which must be deducted in order to arrive at the quantities distributed to the factory.

appreciated but where no technical engineer is employed, graphical load curves, meter readings, and similar records are kept. Unfortunately the full value of such records is seldom secured as they are rarely based on careful comparisons. The highest economy is always obtained where a close study is made of systematic records, whereas records poorly or indifferently kept are worth little or nothing. To be effective, records on water, steam-power, and air must include:

1. Daily numerical tabulations of the log.
2. Calculations from the log data, tabulations, and study of operations within 24 hr.
3. Monthly calculations and tabulations completed within 72 hr. after the end of the month.
4. Weekly, monthly, and yearly graphical reports for the management. These reports can all be made on the same form.

Typical record forms and a graphical report for a small boiler room are shown in Figs. 1 to 4, inclusive.

Engineering Department
BOILER ROOM PRODUCTION

Month_____ Shift-Night
Year_____ Day

Date	Average Feedwater Temp. deg. fahr.	Average Boiler Pressure lb.	Lb. Water Evap.	Boiler HP. Produced	Boiler HP. Operated	Demand Factor Per Cent	Monthly	
							Tons Coal Fired	Lb. Water Evap. per Lb. Coal Fired
1								
2								
3								
4								
5								
6								
7								
8								
29								
30								
31								
Totals Average								

FIG. 2 A TYPICAL FORM FOR RECORDING BOILER-ROOM PRODUCTION

Typical record forms and a graphical report for a small boiler room are shown in Figs. 1 to 4, inclusive.

THE GRAPHICAL REPORT AND ITS FUNCTIONS

Economical operation depends on immediate study and analysis of the daily collection of essential data. The information thus obtained is needed by management for co-ordination of production with operation. Graphical reports furnish simple, effective, and quick media for comparisons and are rapidly finding favor with executives. At first co-ordinate curves were generally used for this purpose, but in recent years the semi-logarithmetic curves have been more extensively employed, due to the fact that by their use the ratios between related subjects can be shown. A typical semi-log report is presented in Fig. 4 which will serve as an illustration. If the boiler horsepower had been shown on co-ordinate paper the demand factor, or the ratio between the horsepower produced and operated, would also have been needed. With the ratios obtained by semi-logarithmetic paper this additional curve is unnecessary. The information furnished shows quickly the gradual increase in steam production accompanied by a gradual decrease in the boiler capacity fired, reduction in the labor required, and decrease in the coal consumption per unit of steam generated. The most important curves are those entitled "Lb. of Water Evaporated per Lb. of Coal Fired" and "Number of Firemen—Daily." Finally it is evident that the fluctuations of the first week, due to absence of engineering control, were gradually corrected by intelligent use of the log. Here we have a vivid example of the difference between the power plant which takes care of itself and the one which is checked up and directed. In addition to the steam gages required by law and a draft gage for each boiler the most necessary instruments for a small boiler-room include a feedwater or steam meter and a feedwater thermometer. High and low-pressure steam gages, a speed counter, and a steam indicator are needed in small engine-rooms, and when electricity is generated the indicating ampere, volt, and wattmeters are also required. Hourly readings, on a log similar to that of Fig. 2, are taken by the operating engineer or fireman. The steam indicator is used at least once a month to investigate the adjustment of the engines and to aid in readjustment, and is also used for test purposes in checking up loads and steam consumption.

The economy of the log, and of systematic records generally, can be appreciated only after experiences similar to the following. The operating engineer of a certain rubber factory requested an additional 500 boiler hp. and stated that he would be unable to hold the load without its aid. Boiler and engine logs were started at once as a check on the request. The data secured showed that, with the exception of the only stoker-fired boiler installed, the boilers were producing not more than from 35 to 50 per cent of their rating. Immediately a gradual reduction in the number of boilers operated was started and, within 7 weeks, 750 out of 2000 boiler hp. had been shut down. This made possible the transfer of four firemen to other work and a considerable saving in coal. In the meantime the load on the boilers had been gradually increasing and soon reached 160 per cent of its former value. Needless to say new boilers were not installed.

SOME STEAM LOSSES UNCOVERED

The wastage uncovered by some steam surveys made recently is given in Table 1. With the exception of Item 3, which represents the use of slack coal, the table is given in terms of run-of-mine bituminous coal from West Virginia or Kentucky fields. In view of the wide range of prices at different seasons, the variations in the quantities purchased, and the different methods of handling, the actual cost to the consumer has little or no value from a comparative standpoint. These data

will indicate to some degree the enormous wastage in fuel of which a large part could be corrected at very slight expense. The wastage in the cases studied ran from 7 to 47 per cent of the total coal consumption. In the case listed under number 6 the operation of the engine would have been unnecessary, and the wages of an engineer at 55 cents per hr. would have been

Engineering Department
BOILER ROOM CONSUMPTION DATA

Month_____ Shift-Night
Year_____ Day

Monthly Steam Consumption.			
Equipment	Hourly Charge	Hours Operated	Total-Lb.
Feedwater pumps			
Vacuum pump			
Stoker engine			
Soot blowers			
Ash conveyor			
Totals			
Monthly Electric Power Consumption			
Equipment	Hourly Charge	Hours Operated	Total-Lb.
Coal conveyors			
Coal crusher			
Blower			
Totals			

FIG. 3 A TYPICAL FORM FOR BOILER-ROOM CONSUMPTION DATA

The hourly charge should be based on the boiler-room production and also on the number of boilers in operation. This factor will, of necessity, change from month to month, due to the different operating conditions, and it should be determined either by calculations or test results.

saved, if the load had been carried on the low pressure turbine. But this was impossible because of leakage in the condenser which had not been cleaned for 5 years. The resulting poor vacuum condition cut down the maximum load of the turbine 50 per cent. Repairs to the condenser cost only $800. Over . .6200 expenses per year eliminated by an expenditure of $800. This may be called a saving, but what shall we say about management which allows such waste to go on year after year? The data presented constitutes an approximation of general conditions found in the usage of coal fuel.

Some of the leaks in power plants operation which are common and which occasion much financial loss are given below:

Steam

1. No insulation on boiler-drums and steam-pipes. At 100 lb. boiler pressure 1 in. of good insulation on 4-in. pipe will conserve about 1 ton of coal per year per foot of pipe.
2. Poor adjustment of engines and compressors. Valves and eccentric should be set by steam indicator and the engine should be indicated, as a check, monthly.
3. Heat loss through flues and chimneys. Use damper regulator and draft gages. Obtain flue gas analysis frequently.
4. Hand firing. Where coal and other limiting conditions permit employ stokers which will produce 50 to 150 per cent more steam than hand firing with same boiler. Stokers also enable management to reduce the size of new boilers.
5. Return tubular boilers. Use water-tube boilers if possible and thus avoid wastage of coal due to "short-circuiting."
6. Offal firing. Where waste lumber, sawdust, ground oak bark from which tannic acid has been leached, etc., are used an oversupply of air is introduced in the combustion chamber. Extra air cools the furnace and produces an excess of carbon monoxide. It may pay to sell or give away this offal. Oak bark often contains 50 per cent moisture which must be driven off. Evaporation is thus reduced about 60 per cent and extra coal is burned to furnish this extra heat.
7. Lineshaft loads. Many factories can cut their engine loads down from 5 to 25 per cent by the use of ball bearings.
8. Inefficient pumping equipment. Steam siphons, injectors, ejectors and even steam pumps of the reciprocating type use much more steam than the turbine steam pump. When one considers that 5 per cent of the steam generated is often used on boiler feedwater pumping the advantage of economical equipment can be readily seen.
9. Leaky steam traps and drips.
10. Large, slow-speed simple expansion engines. Compound engines, uniflow engines and turbines, with their various combinations, give much better economy. The difference in first cost is often repaid inside of 2 years.
11. Air leaks through boiler settings.
12. Failure to properly clean out ashes and the deposits of soot and scale.

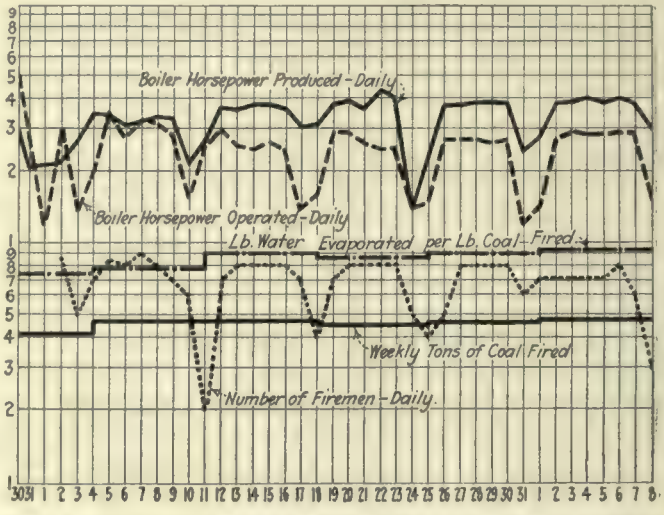
Boiler Horsepower Produced - Daily
Boiler Horsepower Operated - Daily
Lb. Water Evaporated per Lb. Coal - Fired
Weekly Tons of Coal Fired
Number of Firemen - Daily

FIG. 4 A TYPICAL CHART OF BOILER-ROOM OPERATION PLOTTED ON SEMI-LOGARITHMETIC PAPER

Water

1. Inefficient pumping equipment. Leakage due to poor adjustment.
2. Drinking fountains. Allowed to run constantly during warm weather to secure fairly cool water. One fountain with a ¼-in. pipe connection will pass more than 3 gal. of water per min. at 70 lb. water pressure. Iced coolers with pipe coils or refrigeration should be used.
3. Leaky valves, pipes, boilers and plumbing.

4. No steam separators. Water is often carried out of boilers and thus endangers engine and pumping equipment besides the constant reduction in the quality of the steam.

Electric Power

1. Inefficient generation of power due to antiquated equipment.
2. Heating. This may be caused by overloading, poor repairs, improper connections or bearing troubles.
3. Poor illumination. Use of improper materials, selection of fixtures which are not suitable and colors used on ceilings and walls. Employment of incandescent lamps which have already burned over 1000 hr. and should be discarded because they furnish less light and consume more current.
4. Short circuits.
5. Improper wiring. Wires undersized and not installed as per the National Electric Code. The records of the National Board of Fire Underwriters show that from 6 to 7 per cent of all fire losses are due to this cause.

Compressed Air

1. Leaky valves, pipes, hose and pistons.
2. High frictional losses due to many turns and elbows.
3. Moisture in receivers and pipe lines which are "pocketed."

To illustrate the proper analysis of a boiler-room problem the following is presented. This boiler-room contains two 200-hp. hand-fired water-tube boilers, 15 years old, operating at 150 lb. pressure. Contemplated factory changes make additional steam capacity necessary. Study of the boiler log data shows that the average and maximum loads will reach 450 and 650 boiler hp., respectively. The chimney is of sufficient size to take care of 750 boiler hp. Due to furnace conditions only stokers of the chain-grate type can be used with the old boilers and this addition to the equipment would not carry the load. The problem therefore resolves itself into what combination of boiler and stoker equipment will best meet the new condition.

Tabulation develops the fact that the combinations which satisfy the requirements are as follows:

Combination	Equipment
1	1 new 150-hp. water-tube boiler 1 underfeed stoker for above boiler 2 chain-grate stokers for old boilers
2	1 new 150-hp. water-tube boiler 1 underfeed stoker for above boiler 1 chain-grate stoker for one of the old boilers
3	2 new 200-hp. water-tube boilers 2 underfeed stokers for above boilers (This equipment to replace old boilers)

In order that a basis of comparison may be obtained between the various combinations of equipment listed above, the vestance, or equivalent cost of permanent service, must be obtained. The total vestance in any investment consists of the sum of the depreciation and operating vestances. Depreciation vestance is the first cost divided by the factor:

$$1 - \frac{1}{(1 + R)^n}$$

in which R is the rate of interest and n is the life in years of the equipment. Operating vestance is the year cost of operation, which is continuous, divided by the rate of interest. Analysis of the problem under consideration is presented in Table 2.

TABLE 2. VESTANCE ANALYSIS OF THREE COMBINATIONS OF BOILER AND STOKER EQUIPMENT.

Item	First Cost	Life Years	Department Vestance	Operating Cost—Year	Operating Vestance	Total Vestance
First Alternative						
Boilers	$6,000.00	25	$8,000.00	$12,500.00	$208,300.00	
Pipings	6,000.00	25	8,000.00			
Stokers	7,000.00	15	12,000.00			
Coal Convey.	9,000.00	15	15,400.00	1,400.00	23,300.00	
Foundations	8,000.00	Perm				
Totals	$36,000.00		$43,400.00	$13,900.00	$231,600.00	$275,000.00
Second Alternative						
Boiler	$6,000.00	25	$8,000.00	$13,800.00	$230,000.00	
Piping	6,000.00	25	8,000.00			
Stokers	4,800.00	15	8,300.00			
Coal Convey.	5,000.00	15	8,600.00	1,200.00	20,000.00	
Foundations	6,500.00	Perm				
Totals	$33,300.00		$32,900.00	$15,000.00	$250,000.00	$282,900.00
Third Alternative						
Boilers	$12,000.00	25	$16,000.00	$12,200.00	$203,300.00	
Pipings	6,000.00	25	8,000.00			
Stokers	5,000.00	15	8,600.00			
Coal Convey.	7,000.00	15	12,000.00	1,200.00	20,000.00	
Foundations	7,500.00	Perm				
Totals	$37,500.00		$44,600.00	$13,400.00	$223,300.00	$267,900.00

A comparison of these three propositions as revealed by the table shows that:

1. New 200-hp. boilers with stokers will cost 1.04 times as much as proposition No. 1 and 1.13 times as much as proposition No. 2.
2. The third proposition has a comparative value of 1.03 times as much as proposition No. 1 and 1.06 times as much as proposition No. 2.

Furthermore, the third proposition will furnish a maximum capacity of 1000 boiler hp. as against 975 boiler hp. for the first proposition and 825 boiler hp. for the second. When the load increased beyond the

point contemplated, induced or forced draft can be installed and the maximum capacity of the new boilers obtained. The third proposition should, therefore, be selected.

The example furnished does not take into consideration taxes, fire insurance, careful analysis of load and operating conditions, service, quality, and outstanding data which often throw a different light on a problem, but it does furnish the reader with a clear conception of proper analysis.

Organization in industry *658.3*

The Administrative Order and Its Place in the Industrial Organization

By C. L. WHITE

With The Pierce-Arrow Motor Car Company

TO act intelligently, or even effectively, one must have complete information. Furthermore, if the information is to be used so as to secure the full force of action, it must be reliable and authoritative.

To meet the need of an organization, as far as the initiation and distribution of orders and information are concerned, the Administrative Order has been developed and used successfully in a number of large organizations. The Administrative Order has been defined as an order which may affect two or more of the larger groups of the complete organization, and in general it will cover the following subjects:

1. Statement of company policies or plans.
2. Outlining the organization with the responsibilities of the different portions thereof.
3. The appointment of change in status of executive personnel.
4. The establishment or transfer of departments.
5. Changes in hours of work or declaration of holidays.
6. Promulgation of special, general, or emergency procedures.
7. Clarification of any complicated situation or misunderstanding.

It is believed that the Administrative Order should originate no lower in the organization than the second stage from the chief executive. For example: If the president and general manager is the chief executive, and has reporting to him the company officials who might be termed the heads of fundamental groups, and as each of these company officials have in turn reporting to them the heads of divisions, it is submitted that the Administrative Order should not originate below these division heads. Also in order that the Administrative Order may be fully authoritative, it should be signed by the division head who originated it and also approved by his immediate superior.

In physical form the Administrative Order should be distinctive but not necessarily elaborate. One large industrial organization employs a company letterhead, punched for ring binder, with the words "Administrative Order" below the company name. This is printed on a light grey bond paper, and heavy tag stock folders or binder covers of a similar color are provided for all executives having complete sets. The set-up is very simple—comprising the serial number and "date effective" in the upper right-hand margin, and the "To" and "Subject" placed as usual. Paragraphs are numbered with roman numerals and subdivided where necessary with arabic and lower case alphabet.

In order that there may be sufficient number of files of Administrative Orders available throughout the organization, complete sets of the orders should go to each individual authorized to initiate them. Furthermore, such orders should go to them whether they are affected by them or not, for it is not always possible to definitely state whether or not the head of a division is interested in a particular Administrative Order, since one executive cannot definitely and fully state the desires or needs of another executive, especially in a large organization with its many ramifications.

"First Mail" and "Second Mail" Orders

A plan which has been worked very successfully for executives below the division heads (the lowest line authorized to originate them) has been called "First Mail" and "Second Mail"—First Mail comprising all those who report directly to the division head, and Second Mail all executives below them. Such an Administrative Order list is made up with the titles of the executives holding complete sets of Administrative Orders typed even with the left margin, the First Mail classification being indented five spaces and the Second Mail classification indented ten spaces. By separating the executives in the list into their proper functional groups of the organization, it is thus possible to quickly pick out any group of executives to whom the Administrative Order should be sent.

The complete sets of Administrative Orders should be inspected periodically and date stamped at the time of the inspection. At the time of inspection those orders which are "Canceled" should be so stamped. Naturally some orders clearly designate the duration of their enforcement, others are nullified by subsequent orders. For example: A change in executive personnel might be automatically "Canceled" or "Voided" by a subsequent order covering the same positions. Again, we have cases where orders are largely educational and, although their force is spent, require no formal cancellation. Only those orders need to be "Canceled" which, on their face or from their nature, would not otherwise be so understood.

The results obtained from the use of the Administrative Order more than repay the slight cost of its rather wide distribution. The information which the order conveys is authoritative, and therefore reliable. Moreover, the executive receiving the order knows exactly what course to pursue, and even if the Administrative Order does not affect him, he becomes informed of what is going on in other divisions, and such information often inspires the executives to greater accomplishments in their own divisions.

658.9 : 666.26
666.26 : 658

Improving Enameling Equipment and Practice

How Changes in Plant and Method "Balanced" Production and Secured Uniform Quality of Output

By EDWARD H. TINGLEY

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PRODUCTION in a plant cannot be balanced if any one department falls behind in producing its share of the output, for the whole principle of "balanced production" is thereby nullified and all its benefits are lost. Moreover, if a particular department is unable to pass along the work as promptly as it receives it, the money spent in perfecting the other departments is, to a large extent, wasted. Where, for example, is the profit in having machinery and tools to machine the parts on 400 units a day if the enameling department can only enamel 250 sets of parts per day? Such, however, was the condition of certain products in our plant a year ago. Observing the fact that day and night shifts were operating the enameling ovens continuously, and on the other hand that the enameling department was always overcrowded, the management came to the conclusion that this department was "the neck of the bottle" and that it should receive generous and prompt attention. The nature of the changes introduced forms the basis of the present article.

FIG. 1 A VIEW OF THE SPRAY BOOTHS AFTER THEY WERE REMODELED AND SEPARATED FROM THE BAKING OVENS

This spray room is completely partitioned off up to the roof, and the doors to all entrances and exits are kept closed, thus eliminating dust coming from other departments and from the street. Working conditions are thus improved and rejections of production due to dusty surfaces are practically eliminated.

First of all careful time studies were made of all the work done in the department and piecework rates set for all spraying, dipping, filling, sanding, and cleaning operations. This brought about improvement in the time element at no sacrifice of quality. The tending of the ovens and the labor of trucking in the department were paid day rates. Electric heaters were also installed in the ovens and the baking time was at least quartered, so that now there is never a time that the spray booth men must stop work because they have more work sprayed than can be baked at once in the ovens. This insures satisfaction with the piecework rates. Three typical types of work handled together with the time set and production attained are shown in Fig. 2.

In bringing about a return of "balanced production" it was also necessary to modify to some extent the plant layout. Space for the storage of incoming and outgoing material, for sprayed pieces, for pieces cooling, for material to be given the second coat and for the cleaning operations was also lacking. And so a new and larger location was secured which permitted making separate rooms for the spraying and dipping, for the baking ovens, for the filling and sanding, and for the cleaning. Each group was given sufficient space to store its work in process, but proportioned to the needs of the whole department.

The dipping and spraying of the enamel had formerly been done in the same room with the baking ovens, with the result that the wet pieces picked up dust and dirt which was later baked in, and since the inspector would require such work to be done over, delays were frequent. To reduce to a minimum this slackening of the production and also to secure a better product and better working conditions for the operators, a separate room was partitioned off to be used exclusively for spraying and dipping. Fig. 1 shows this room with its row of spray booths all electrically lighted and connected to a suction system of ventilation which draws the spray-laden air out of the spray booths, expelling it through a large stack out above the roof. To further increase the surety that the enameled work will pass inspection and have a good smooth surface all sheet metal pieces are now first cleaned in an alkaline solution to remove grease,

oil, etc., and then baked in the ovens until they become straw colored. They are then removed and wiped with a cloth upon which has been placed some varnish. The varnish becomes tacky and picks up every bit of dust. The work is immediately sprayed and as soon as a truck is filled it is taken to the oven and baked. When cool enough to handle, it then receives a second coat, is baked again and after inspection is sent to the finished stock department. By this method the rejections due to dusty surfaces have been practically eliminated, thus expediting the progress of the work through the enameling department.

small parts at a time, for a loss of both time and enamel occurred when an attempt was made to spray each small part singly. Dipping tanks have been installed and by this means, where no harm is done by having both the inside and outside of a piece enameled, much faster results are obtained. Dipping is no more wasteful of material than spraying, so the time element is most important. Special racks are made to permit dipping 10 or more pieces at a time, hanging the same racks up to drain and later placing them on the trucks to be put in the baking ovens. In order to save time handling is reduced to a minimum. Fig. 3 shows the truck used in

FIG. 2 THREE TYPICAL TYPES OF WORK HANDLED IN THE ENAMELING DEPARTMENT

LEFT—Five-gallon Kerosene Can. Spraying one coat enamel (actual time) 1.86 min. per piece. Production, including all time and personal allowances to operator, 24 tanks per hour.

CENTER—Draft Tube and Bracket. Spraying first coat of enamel (actual time) 0.72 min. per tube. Production, including all time allowances, 68 draft tubes per hour. Spraying second coat of enamel (actual time) 0.53 min. per tube. Production, including all time allowances, 86 draft tubes per hour.

RIGHT—Water Tank Assembly. Spraying first coat of enamel (actual time) 2.36 min. per tank. Production, including all time allowances, 19.3 tanks per hour. Spraying second coat of enamel (actual time) 1.86 min. per tank. Production, including all time allowances, 24 tanks per hour.

Formerly the compressed air used in the spray booths was obtained from the shop air lines but this gave trouble due to the water and oil being in the air. The pressure also varied considerably during the day, too high pressure causing pitting, as the enamel is forced against the metal with too great a force. It has been found that 80 lb. air pressure gives the best results and this is automatically maintained within a few pounds by a motor-driven air compressor, a large storage tank, and an air-operated electrical switch. A change in pressure operating through the switch will start or stop the motor.

To overcome the trouble of oil and water in the air, individual separators are located at each spray booth to remove these elements from the air and keep them from mixing with the enamel as it is sprayed on.

Because of the small number of spray booths in the plant various racks, combination fixtures, etc., were experimented with to allow the spraying of a number of this work with individual pieces hung on pipe rods ready for baking.

If a smooth surface after enameling is desired on iron castings, the roughness must either be ground off or a filler used. To save the grinding operation which on some castings was almost impossible due to the irregular contour, an iron filler is used which is glazed on the surface with a knife. The castings are then baked for 2 hr. at 250 deg. fahr. but under conditions of heavy production the baking temperature is raised to 350 deg. fahr. and the time reduced to 1¼ hr. When cool the surfaces are sanded to remove all roughness and then given a coat of sprayed enamel. This is immediately baked for 2 hr. at 350 deg. fahr. This method gives a fine appearance to the work.

By far the larger part of the delay in the enameling department, however, was found to be due to the long time required for baking in the ovens. (See Fig. 4.)

This averaged 6 to 8 hr. and necessitated a day and night shift to get out the work. The ovens were heated with fuel oil or natural gas and air, but the temperature was never very constant. The temperature at the top of the oven was much higher than at the floor, which resulted in the material on the top shelf of the truck being overbaked to give a proper baking to the material on the lower shelf. This made necessary the re-enameling of much material with consequent delays in an already delayed department.

It was decided that when the ovens were moved to their new location the fuel oil and gas heating methods be discarded and electricity installed. The entire 5 double ovens were accordingly equipped with nichrome ribbon oven heaters, 72 to an oven, and these connected to a 3-phase, 60-cycle, 440-volt power line through a separate control panel for each oven. This panel has two circuits, each controlled by magnet switches. One circuit has a capacity of 90 kw. and is called the "constant heat" circuit as it is always connected while the oven is operating. The other circuit has the same capacity but is controlled by relays, which in turn are operated by a recording and indicating pyrometer located in the foreman's office. This is called the "automatic" circuit, because as the temperature of the oven rises to the fixed point, say 350 deg. fahr., it is automatically cut out, remaining out until the temperature has dropped to the other fixed lower temperature, when it is automatically thrown in again. Thus the heat is kept constant within very narrow limits, not over 5 deg. fahr. A limit of 30 min. was allowed for bringing the ovenful of metal to the baking point, and not over 2 hr. was allowed for baking, thus setting a rate of production that would give the enameling department a capacity greater than any other department and equal to the requirements of all plans for the future expansion of the factory.

The plans for increased production also considered the safety of the operators and preservation of equipment. Previously when the ovens used gas or fuel oil as fuel, frequent minor and serious explosions took place due to unburned gases being present in the ovens, for it was very hard to regulate the supply of air so that combustion was complete. Starting the ovens was the most serious time, as explosive mixtures would often form in the burners. With electric heaters, however, since electricity is radiant energy, no air is required for combustion and this insures safety and quick heating of the ovens. Moreover, electricity also being a source of constant heat a uniform temperature was secured, and this, of course, resulted in uniform baking with a consequent elimination of all tendencies to blister or peel off.

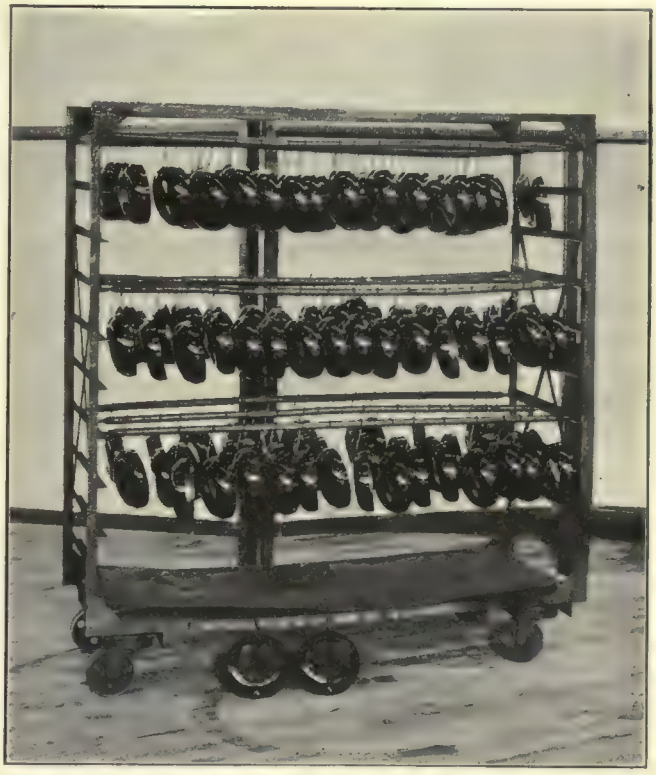

FIG. 3 THE SPECIAL TRUCK USED TO HOLD THE SPRAYED MATERIAL WHILE BAKING IN THE OVENS

The close spacing of the angle iron end supports allows a variety of the pieces to be hung on the one truck. It is made as high as the roof of the baking oven will permit, thus utilizing the full space of the oven.

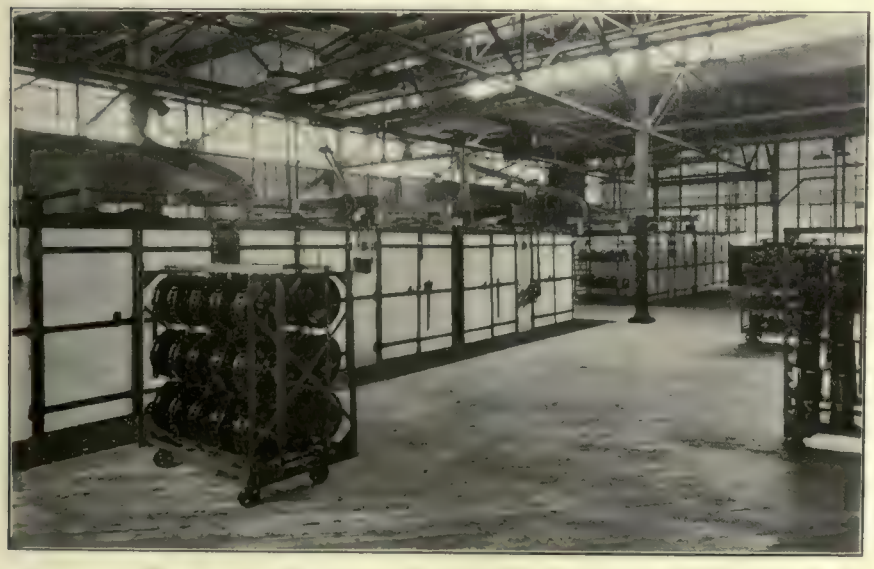

FIG. 4 A VIEW OF THE ELECTRIC BAKING OVENS SHOWING SOME OF THE SPECIAL TRUCKS USED TO HOLD MATERIAL

These electric baking ovens are automatically maintained at a constant temperature and production is thus stabilized because of uniform operating conditions. Moreover, due to their reliability and freedom from fire hazards production can be easily speeded up and output thus increased.

In enameling too high a heat causes the outside layer of the enamel to set before the casting is heated enough to cause the inner layer of enamel to bake, and so when the solvents in the enamel in the inner layer volatilize and penetrate the outer layer they leave holes or blisters which will not

close up. Naptha, which is used in the enamels, is the first of the solvents to be driven off as the oven heats up. In the gas-fired type of oven, the naptha coming in contact with the flame would ignite, causing an explosion. With electric heaters, however, explosions due to naptha fumes are prevented by regulating the temperature, automatically keeping it below the explosion point. If the oven is properly ventilated so that there are at least 15 changes of air per hour, the naptha fumes will be drawn off and the temperature will be too low to explode the diluted mixture.

Ventilation is, moreover, not only important as a safety measure but is essential for the prompt and proper baking of the enamel, which is accomplished in three steps:

1. The naptha is vaporized.
2. Heavy oils are volatilized and driven off.
3. Enamel is oxidized and hardened by the fresh hot air.

It is necessary, therefore, that any ventilation system should provide sufficient capacity to remove the fumes and give enough fresh air for thorough oxidation.

The present method of ventilation is shown in Fig. 5. The heaters are below the floor in a concrete pit about 24 in. deep extending entirely under the oven floor. The incoming fresh air is drawn down a pipe inside the outgoing gas pipe, thereby preheating it before it is expelled on the floor of the pit in the center between the heaters. This air is heated in passing through the heaters and runs up along the walls of the ovens, goes through the enameled work, absorbing fumes, and passes out the ventilator on the floor in the center of the oven. An exhaust fan causes this circulation of air to take place and expels the fumes through a pipe outdoors. The oil fumes being heavy are always at the floor level instead of at the ceiling as might be expected. The location of the exhaust pipe on the floor at the center of the oven gives the proper circulation of the air through the work, thereby producing complete oxidation and consequently quick baking and good work.

The ovens are now run continuously after they are brought up to baking temperature in the morning. The wet enameled parts are put in the front of the oven and, when baked, taken out at the rear. Whenever a truck load is ready to be baked it is put in any oven where there is a space, and is never left on the floor to gather dust. This continuous process thus insures the maximum efficiency of every oven and gives greater productive capacity to the set of ovens as a whole. As a rule similar kinds of material are put in one oven, or at least those kinds requiring the same temperature.

THE FOLLOW-UP METHOD EMPLOYED

To avoid delay in passing material through the department, especially material which is required to have a second coat of enamel, a special method of follow-up is used. The production order accompanies the work to the enameling department and a duplicate copy of the order is retained in the foreman's office as long as the material is being worked. A given date when the material should leave the department is stamped on the orders, which are then filed according to their due dates. The foreman, in assigning the work to his men, looks through this file and selects those orders the due dates of which require them to leave the department earliest. When work is started on any order the clerk transfers the duplicate of the production order to a "Work in Process" board, which is checked daily to prevent delay in getting these orders finished.

The copy of the production order, which is placed in a sheet-metal container and hung on the truck or box, follows the work through all the operations in the department. The workman is responsible for the order moving with the stock and only removes it when he takes it to the office to have his time slip made out. When the material goes into the baking ovens, the production order in its container is removed and hung on the door until the baking is finished. It is then placed on the truck to accompany the material to the cleaning and inspection benches.

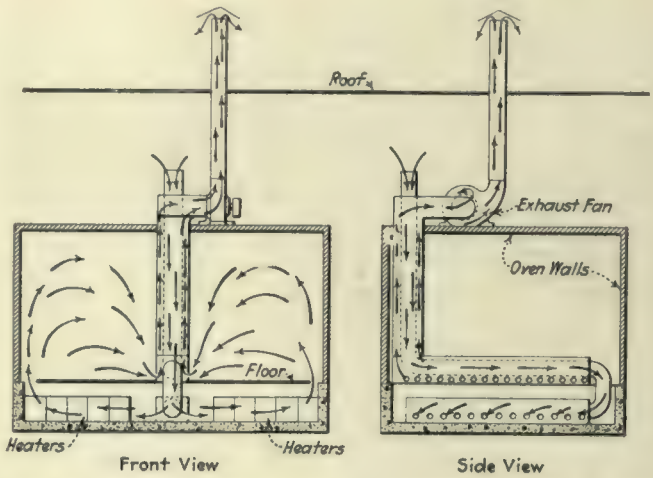

FIG. 5 DIAGRAM SHOWING THE VENTILATING SYSTEM EMPLOYED IN THE ENAMELING OVENS

The incoming air is drawn down a pipe which is inside the outgoing gas pipe, and is thus preheated before it is expelled on the floor of the pit between the heater.

FINAL OPERATIONS TO ELIMINATE DELAYS

Interchangeable manufacture requires that all parts going to the final assembly be interchangeable and have no fitting or adjustment necessary. To agree with this, all castings that have been enameled are cleaned on belt sanding machines, or by hand. All threaded holes are retapped, all machined surfaces cleaned, holes that are not tapped are reamed and the enamel removed from any part that would cause any delay on final assembly.

The changes and improvements described, introduced with the sole object of speeding-up production, have made the enameling department one of the model parts of our factory, thus restoring confidence to the foreman and his men, as they know that their equipment can be relied upon to produce excellent work in the minimum time without delaying an important portion of the plant production.

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Making Industrial Capital More Productive

The Efficiency of Working Capital Can be Increased as Well as The Effectiveness of Labor and Machinery

By W. L. CHURCHILL

President, McDonald-Churchill Corporation

WHEN Frederick W. Taylor and his co-workers first called attention to the appalling inefficiency of labor, due to its lack of scientific management, it was difficult for us to accept as reliable the estimates then given that labor was not producing over 50 per cent of what it might produce under proper management. Contrasted, however, with fact after fact which we have since learned, the original estimates now seem extremely conservative, especially in view of the advances in management engineering that have since taken place and that were little dreamed of when it was first suggested as a science.

Since that time much effort has been expended to increase the effectiveness of labor, machinery, and equipment, and with noteworthy results, but only too often we have overlooked the equal importance of increasing the efficiency of capital as well. And yet industrial capital stands in as much need of improvement and is as capable of being made more effective as the other agencies of productivity.

A Problem of Turnover vs. Stocks

The problem is this: A large proportion of working capital in industry is invested in raw materials purchased for use in manufacturing. Another large proportion is invested in goods-in-process of manufacture, including components made in advance of anticipated or hoped-for demands. In addition to these two divisions of the merchandise inventory, a third large part of capital is invested in the stocks of completely finished products or articles, carried by manufacturers to meet expected sales. The total amount of capital invested in these three forms of merchandise inventory reaches a stupendous sum in American industry. Hence if any considerable proportion of this investment is unnecessary, we have a tremendous amount of idle capital.

So far is this the case in the writer's opinion that it is his conviction that fully 50 per cent of the capital now invested in the merchandise inventories of manufacturers could be released, not only without the sacrifice of any advantage, but with an actual gain in all other directions of industrial operation. Indeed many manufacturers could profitably reduce their present merchandise inventories 80 per cent or even more.

How can the effectiveness of working capital in industry be increased? In exactly the same way that labor efficiency has been increased—by applying the principles of management, making every dollar invested in merchandise inventories do more work, making one dollar do the work which now requires several.

Idle capital is a form of over stock. Not alone is it expensive because of its cost but it creates unhealthy conditions. Reduce its amount and increase its rate of turnover, and then instead of large idle stocks of materials, goods-in-process, and finished products, the stream of production, though small, will flow rapidly.

Industries such as flour mills, saw mills, and others, which obtain their annual supply of raw materials through a short growing or hauling season, have rather definite limitations to their turnover. Likewise industries that depend for their chief raw materials upon imports from distant and unreliable sources have a purchasing problem which restricts turnover. In addition, there are a few lines of manufacture whose processes or seasoning operations are such as compel large investment in their in-process materials and thus automatically prohibit rapid turnover of capital investment. Aside from these exceptional industries, however, there are few that cannot improve their present rate of manufacturing turnover.

The manufacturer whose annual sales are not more than six times his merchandise inventories, unless he is in one of the exceptional classes, is neglecting an opportunity for betterment which might easily be the means of solving many of his financial, sales, and operating problems.

To most manufacturers the thought of turning over merchandise inventories six times a year sounds impractical and even impossible, since two, three, and four turnovers per year are commonly considered achievements, and there are many concerns whose investments in stocks of materials equal if not exceed their annual sales. And yet six turnovers per year are by no means the maximum; there are many manufacturers obtaining as high as 12, and a few as high as 25.

Reasons for Slow Turnover in Manufacturing

Materials turnover is a subject which has been given but casual attention among manufacturers as a group, although its value in merchandising is more generally appreciated. One of the reasons for this neglect is that, as a rule, it is far more difficult to obtain as many turnovers per year of capital invested in manufacturing as in merchandising a given product.

The merchant buys and sells definite articles. The manufacturer, on the other hand, sells certain goods but buys a great variety of dissimilar materials and articles from which to produce the goods. The manufacturer's problem is so much more complex than the merchant's that he is apt to consider it impossible even to approxi-

mate the merchant's standards in this respect. Then, too, it has always been easier to obtain capital with which to carry merchandise inventories required for manufacturing purposes than to obtain the skill, initiative, engineering, and executive ability required to do a large manufacturing business with limited stocks of materials, parts, and finished products.

Much attention has been given to automatic machinery, methods, and processes in American industry. These call for relatively large outputs to enable maximum economies to be secured, and consequently they encourage investment in unnecessary materials, parts, and completed goods. It has been thought impossible to produce many articles and component parts of products economically except in large quantities. This in turn has occasioned their accumulation and storage for possible future use.

Another consideration that has been responsible for the accumulation of such inventories has been the belief that with goods, parts, and materials on hand, orders could be filled more promptly than slow manufacturing processes would otherwise permit.

An additional factor that is largely responsible for these accumulated stocks is the piecework or individual bonus systems of wage payment. Hundreds of thousands of dollars' worth of unnecessary products and useless parts have been made in order that such workers could be kept on a basis of wage payment that would insure a low labor cost per unit produced.

Excessive Stock an Economic Waste

Most manufacturers find that their inventories include considerable quantities of obsolete and slow-moving materials, goods-in-process, and finished products. These, indicating directly an appalling ineffective use of capital, are an economic waste and a heavy handicap to the growth of industry.

The average manufacturer looks at these stocks with satisfaction at the thought that he is so well supplied, rather than with the dissatisfaction he should feel over their idleness. Though he would be highly incensed to see idle workmen in his plant and would take immediate measures to eliminate them from his pay-roll, he yet looks with favor upon lazy stocks, not realizing that they are costing him as real money as idle workmen. He would refuse to permit crowds of onlookers to stand around where they could interfere with the activities of his workers. And yet he not only tolerates, but actually provides space and conveniences for idle stocks to obstruct and interfere with production.

Up to quite recent times it has apparently been taken for granted that so long as capital was cheap and easy to obtain it was hardly worth while to expend much effort in devising ways and means to make it more productive. Wherever capital investment has been reduced to minimum proportions through maximum turnover, it has usually been as a result of plans for other benefits and has come about as a by-product of such plans rather than as their primary object. The attention which capital has received, as to its productive use, has been almost accidental, and largely because of its association with labor, or machinery, or possibly both.

The readjustment period through which we are passing, however, has forcibly impressed upon manufacturers and their bankers the importance of conducting manufacturing operations with smaller merchandise inventories than they have been accustomed to carry. The inventory valuations of huge stocks of raw materials, goods-in-process, and finished products have had to suffer such large reductions that in many instances the shrinkage has proved disastrous to the manufacturer and embarrassing to his banker.

Recent Industrial Lessons

In the future, stockholders who have been forced to forego expected dividends on account of reductions in inventory valuations will insist upon a more rational and efficient use of their money, and banks that have been forced to extend and re-extend loans made on the basis of such inventories will be more conservative in such accommodations than ever. Thus strong influences are at work to compel manufacturers to give attention to this subject of material turnover, instead of looking for money with which to carry unnecessary and dangerously large stocks.

Fortunately, we have a number of examples of the advantages of conducting manufacturing operations on a basis of frequent turnover of merchandise inventory and the needlessness of carrying large stocks for successful production. One of the most striking of these is afforded by the contrast between the rapid recovery to a big production basis of the Ford interests and the painful and expensive re-financing of certain of the large rubber companies.

Problems and Effects of Capital Turnover

Increasing turnover of manufacturing investment to the greatest practical limits is a problem calling for most thorough research into every phase of purchasing, manufacturing, and selling, including a study of the organization, administration, finance, and accounting, that go with them. Properly applied, the results of such research will be to increase the volume of business which can be done with the same amount of capital, or to maintain an established business with less capital. More business can be done in the same buildings and with the same equipment, or the established business can be conducted in less space and with less equipment. Deliveries to customers also will be improved and better service will be rendered, thus automatically encouraging more business.

On the other hand, unless prevented by special circumstances or conditions, the cost of certain direct operations and of certain materials will be increased, as quantity production and quantity purchases are sacrificed for frequency of turnover.

The most difficult problem is that of planning and controlling purchases and the flow of production to insure complete and prompt service to customers with a minimum of materials and products on hand at all times. The solution affects the organization, personnel,

methods and rates of wage payment, plant layout, and necessary equipment. Moreover, by a system of frequent turnover, financing and accounting will be affected—accounting because of the increased number and variety of purchases and the greater current variety of production, and both financing and accounting due to the reduced amount of financing required.

Is a Change Worth While?

As the adoption of a policy of frequent turnover, if carried to its logical conclusion, means a complete revision of established organization and routine, naturally the questions arise: Is such a change worth while? What will such a revision of procedure accomplish to justify its adoption and use? The answers to these questions will, of course, vary with the industry under consideration. The proportionate gains may be expected to parallel the degree of change adopted. Coincidentally, the greater the change desired from the established policy, the greater the effort and adjustment necessary to accomplish it.

Although there is no hard and fast rule governing the amount of improvement that may be affected by rapid turnover, the following examples may be cited as a means of helping to decide whether or not substantial improvement may be expected.

One large manufacturer of heating apparatus, radiators, etc., with a number of plants scattered over this country and abroad, has had as high as 21 turnovers per year of the capital invested in raw materials, goods-in-process, and finished product. This has been rendered possible by years of development along lines that have minimized the variety of products and component parts and developed ability to anticipate sales with almost uncanny accuracy. Our largest automobile manufacturer has as high as 25 turnovers of material inventory in one year.

If either of these concerns were to operate on the same basis as its competitors, who have as low as two turnovers per year, it would mean 10 to 12 times as much capital invested in merchandise inventories as at present, and storage and manufacturing space to correspond. The capital investment would have to be increased to a point which would make fixed charges so much greater that the manufacturers could not secure their present high profits, nor hope for the large volume of business they now have.

The Advantages of Frequent Turnover

The advantages of more frequent turnovers are just as readily secured for smaller industries, even for those with the greatest variety of product and for those whose product is such that sales forecasts are practically impossible. The fundamental difference between large and small industries is merely in the ratio of their savings. But frequency of turnover is a fundamental, scientific thing and applies to all alike.

The larger the industry the more readily can maximum frequency of turnover be obtained, and the smaller the variety of products the more frequently can material stocks be turned without sacrifice of direct manufacturing costs. Fortunately, the adoption of such a policy of better utilization of capital permits the development of its advantages by degrees and with as great rapidity as the organization is able to absorb and apply the necessary principles.

Several years ago a certain manufacturer of mattresses and bed-springs found himself so pressed for financial assistance that he was hypothecating his receivables. His business was profitable, but he was always hard pushed for cash. His bankers advised him to increase his capitalization, but he was unwilling to surrender control to outside interests, and was about ready to sell out at a loss when he was induced to adopt a policy of frequent turnover of his merchandise.

In order to increase his manufacturing turnover of materials from two to twelve times per year he was obliged to change his sales lines, territories, and forces, but inside of six months he was in a far better condition. His former 500 styles and sizes were reduced to less than 250. Where he formerly canvassed none but small-town dealers, he switched to large city distributors with fewer but more sizable accounts. Where he had $50,000 in loans on which he was paying bank interest, he now had a $50,000 surplus drawing interest.

Rapid Turnover Not Always Possible

Not all lines permit of reduction in variety of products without sacrifice of trade volume. Manufacturers of jewelry, tableware, social stationery, and other lines calling for continuous changes in styles and patterns, often find it advisable to increase the number and variety of their lines to secure larger volume of business.

Getting out new patterns with each season, all of which have to be tested on the buying public before their salability can be determined, makes for complications which do not occur in lines of staple character. Even with these additional complications, however, it is possible to operate advantageously on a basis of frequent material turnover, and in fact such a basis offers opportunities to supply fresh and assorted stocks to customers which are practically impossible where quantity production is insisted upon.

One such manufacturer had been doing a business of $3,000,000 per year, utilizing all of his working capital, which included a merchandise inventory of $1,250,000. Due to an intensive effort to increase material turnover this business was built up to $5,000,000 per year and the merchandise inventory was reduced to $400,000. Though having a smaller working capital the firm did a much larger business, and instead of issuing stocks or bonds to raise capital it was in position to declare a stock dividend.

Occasionally an established manufacturing enterprise desires to secure added capital to enlarge its market. It finds it has developed a capacity for much greater output than the established market will absorb. To enlarge this market may call for an extensive advertising and sales development campaign demanding permanent investment in distributing agencies, warehouses, and stocks.

One such concern decided that instead of increasing capitalization or bank loans for this purpose it would *take* funds from merchandise inventories by changing the manufacturing policy to one requiring an increase in the frequency of turnovers of such stocks. Although making an extensive variety of products, it found the required capital within a few weeks of starting the turnover plan, and also found that the improved service to customers increased the established trade, while the space made available by the reduced stocks provided for an addition to the manufacturing capacity.

DIFFICULTIES TO BE ENCOUNTERED AND OVERCOME

The simple resolution to turn over stocks a definite number of times per year will not, in itself, accomplish the desired results, without considerable sacrifices in manufacturing costs, unless these costs are modified and their increase prevented by adequate engineering study and changes. To illustrate how the engineer's skill can overcome such handicaps a few representative cases will be cited:

One manufacturer of a line comprising over 2,000 varieties of products, each requiring a specially printed wrapper, had in use cylinder presses on which to print these wrappers. Ordinarily one-half day was required to set-up and make ready a cylinder press for such printing. The general practice was to make six, eight, or more imprints on a sheet. On a basis of production of the entire line every 30 days it was found that many numbers had such ridiculously small output requirements that their cost would be prohibitive if done in the usual way.

A study of the entire printing situation disclosed that three rapid automatic presses, making a single imprint, would do the work of five massive cylinder presses at a much less cost, as each set-up on the automatics required but 15 to 29 min.

This concern had accumulated the equivalent of one year's stock of such wrappers in six years by permitting manufacture only in large quantities. Had such stock been equitably balanced they could have operated a whole normal year without any printing of wrappers. Yet there were hundreds of numbers in the line with no supply, while the stock of others would last for five years unless discarded as obsolete.

A manufacturer of loose-leaf sheets and binders had a similar problem with ruled sheets. The extensive variety of rulings catalogued covered many numbers on which sales were very small. The ruling operations called for as much as a full day to prepare the ruling machines for certain of the forms.

An engineering analysis disclosed the possibility of so arranging the sequence of the forecast requirements that the maximum time required to change from one form to another would not exceed one hour and that the majority of changes could be effected in a few minutes. Adopting this plan would automatically increase plant capacity, as preparation time would be cut to a fraction of former averages.

A manufacturer of magnetos, formerly producing each component on the basis of large manufacturing quantities, found that when he changed to twelve period requirements a whole battery of automatic screw machines could not be operated for a sufficient proportion of their time to justify their use. They were discarded and the space was used for assembly.

Many plants find it necessary to change their entire manufacturing procedure and put operations on a successive basis, which can only be accomplished through the continuous conveyance of material from operation to operation. This equipment, in turn, effects direct reductions in cost, which increase the savings due to lessened fixed charges and are a by-product of doing business with small capital investment.

To what extent can we insist on a rapid turnover of capital without causing counteracting inefficiencies in labor, rise in material costs, breaking down in organization, and general disruption of business?

As before intimated, there is no set rule or formula which will apply to all businesses, even in the same industry. Generally speaking, if the capital invested in raw materials, goods-in-process and manufactured products, is more than 20 per cent of the annual sales there is opportunity for reduction. As a rule, the first reduction in merchandise inventory based on operating on a rapid turnover basis can be equal to 50 per cent of the current inventory at the start.

EARLY GAINS TO BE EXPECTED

A 50 per cent reduction in such merchandise inventory usually can be effected within a few months and progressively improved thereafter until the ultimate practicable limit is reached. It is one of the satisfactory features of the adoption of the period turnover basis of manufacture that its benefits are immediate, definite, and substantial.

One factory manager protested against the adoption of six turnovers per year as against the prevailing practice of the company, because such a plan would practically close down his plant for nine months, as it would be possible to fill orders from material already on hand for that time. Fortunately, the firm decided to enlarge its sales activities so that it would not be necessary to dispense with the manufacturing organization for such a period.

It is not an easy or simple task to switch from a policy of manufacturing only large quantities to one of producing economically the quantities that can be sold in a limited period. It requires ability, experience, and mature judgment to solve the problems involved in such a change of policy, and to overcome the prejudices and objections offered.

Where the necessary ability is used and the cooperation of the organization secured, one of the most satisfactory features of the whole principle is developed. Every department, every executive, and, in fact, every employee, becomes automatically stimulated to keep up with the pace established by the rapidity of turnover of the working capital in use. Any organization whose turnover is exceptionally rapid will be found to be a leader in its line in almost every other phase of business activity.

Industrial Absenteeism, Its Causes and Losses

The Results of a Study Covering a Period of 28 Months and A Working Force of 6700 Persons

By ROBERT S. QUINBY, M. D.

Service Manager, The Hood Rubber Company

WITHOUT exact information it is impossible to go about removing causes of evil. In no field is this statement more pertinent than in the field of industrial waste, and of all the causes for this loss probably none is more easily measurable than the waste due to absenteeism. Absenteeism strikes at the root of the stability of the working force; like high turnover it is the symptom of a disease. When labor is scarce, absenteeism is costly and troublesome. When labor is plentiful, as now, and when forces are reduced to the lowest limit of efficiency, absenteeism is doubly a drag on management.

The lack of reliable information concerning industrial absenteeism is most conspicuous. To date, very little knowledge has been available either as to the amount of time lost by employees in industry, the reasons for this loss, or the methods for minimizing it, nor has the economic loss to industry and its participants on account of absenteeism ever been fully appreciated. It is true that some general surveys have been made, but they have usually covered only brief periods of study, unusual groups of employees, or have been based on questionable methods of collecting data. Most of the studies of conditions in foreign countries have been based on health insurance figures, and the results have not been convincing. One American study was based on a survey of "typical" months. But what is a typical month? The investigation described below made clear that any given month shows phenomena which are not necessarily repeated the same month in the following or in subsequent years.

The Source of the Data

In order to collect sufficiently correct and adequate data on the subject a study of a certain plant was recently completed which covered 28 months, extending from January 1, 1919, to April 30, 1921. Previous to that time it had been the custom to investigate absences in a general way, but the information secured was not sufficiently detailed or comprehensive. On January 1, 1919, a Benefit Plan became effective, and in order to administer it properly it became necessary to make detailed and accurate investigations concerning absenteeism, and to record carefully the results.

That the reader may understand clearly the data about to be presented a few preliminary explanations are advisable. The Benefit Plan which was introduced provided for financial aid in cases of sickness, non-industrial accident and death. After a seven-day waiting period, benefits were paid weekly to sickness and non-industrial accident cases in amounts ranging from $8 to $12, and covering a period of from seven to fifty-two weeks, depending on length of employment, from three months to five years. In cases of death, benefits ranging from $200 to $1000, likewise depending on the length of employment, were paid to those named as the dependent beneficiaries.

All absences were reported daily by the various department heads to the central office, and throughout practically the whole investigation each absentee was visited by a nurse on the second day of his absence. She determined the reason for absence, the probable length of disability, and rendered whatever services were possible or practical in cases of sickness or accident. In addition, all cases of sickness or absence were revisited or came to the hospital personally at least once a week during the period of disability. As the investigation went on the reasons for these disabilities and absences were more carefully checked and looked into, with the result that during at least the last 20 months of the study the information obtained was probably as nearly correct as is possible to collect.

Features of Period Covered by the Study

The period covered by the investigation was unusual in several respects. For one thing, it was a time of unusual business conditions, including a rapid expansion, a peak of production, and then a period of gradually increasing business depression, during the latter months of which a considerable reduction was made in the number of employees. This period included the latter part of the first influenza epidemic and the entire second year of the epidemic, further complicated by unusual weather conditions. In addition to the epidemic proper should be mentioned the numerous and serious sequellae resulting from the primary cases of influenza. All this affected absenteeism and in all probability increased the normal rate—if there is such a thing as a normal rate.

The plant in question during this period had an average of approximately 6700 employees (embracing factory workers alone) 65 per cent being males and 35 per cent females. Fifty-five per cent of these employees were married, and classed according to nationality; 50 per cent were American-born; 15 per cent Italians; 7 per cent English; 7 per cent Irish, and 5 per cent Armenian; while Poles, Greeks, and Lithuanians, totaled 3 per cent each; and all other nationalities, 7 per cent. Classified according to age 15 per cent were under 20 years; 40 per cent between 20 and 30; 24 per

cent between 30 and 40; 13 per cent between 40 and 50 and above 50 but 8 per cent.

As to length of employment, 28 per cent were employed less than one year; 18 per cent from one to two years; 17 per cent from two to three years; 20 per cent from three to five years; 5 per cent from five to ten years; and 12 per cent over ten years.

These facts are worth recording in order to indicate that the group under investigation is a fairly representative one. There was no excess of foreign-born over American-born; neither the young nor the old in years predominated; and a fairly large percentage of the force were, as the phrase goes, "old" employees.

Summary or Basis of Work Days Lost

What, then, did the investigation disclose? The following tabulation sums up the whole story:

Total number of work days lost by absenteeism during 28 months	245,422
Days per employee per year lost on account of:	
Sickness	6.61
Industrial accident	0.45
Non-industrial accident	0.25
Personal reasons	10.95
Total for all causes	18.26

The percentages of lost working time according to the various causes are given in Table 1.

It is, of course, impossible to analyze in detail what are set down as "personal reasons," as it was found that time lost on this account was due to a great number of indefinite causes; moreover, such absenteeism, being of rather short duration, made it doubly difficult to obtain accurate information.

Absenteeism Due to Sickness and Accident

As Table 1 shows, sickness and accident accounted for 41 per cent of the total time lost, while personal reasons were responsible for 59 per cent. It is of interest to note, however, that at times the percentage of sickness and accident disability to the total lost time varied between the extreme limits of 33 per cent and 56 per cent. These variations were brought about both by changes in industrial employment demands and by varying health conditions. The abnormally high influenza rate during part of this period naturally increased the percentage of working time lost on account of sickness, while employment reductions had the effect of decreasing absentees for personal reasons, particularly during the latter months of the investigation.

In examining absenteeism due to sickness and accident according to sex and marital condition, some interesting variations were found. For example, single employees lost less time than married persons. Single males lost less time than single females. Married men lost 2 per cent more time than single men. Widowed and divorced men lost 21 per cent more time than single men; widowed and divorced women lost 154 per cent more time than single males, and married women lost 175 per cent more time than single men. Single women lost 40 per cent more time than single men.

These figures are interesting and worth discussion. It is generally admitted that both married males and females show a smaller turnover than single persons of either sex. In other words, the state of matrimony most probably tends to render an employee more stable and willing and able to stick to his or her job. But on the other hand the study showed that a portion of this stability is sacrificed for the higher absentee rate of

TABLE 1. PER CENT WORKING TIME LOST BY EMPLOYEES FROM JANUARY 1, 1919, TO APRIL 30, 1921

Causes	Per Cent of Working Time Lost	Per Cent of All Time Lost
Sickness	2.036	37.06
Industrial Accidents	0.139	2.52
Non-Industrial Accidents	0.079	1.44
Personal Reasons	3.240	58.98
Total	5.494	100.00

married persons, so that, from the *standpoint of absenteeism alone,* it was found that married and divorced individuals are a considerable liability. Were it feasible to investigate the reasons back of this condition we should probably find them due to the obligations and complications of the home, illness of members of the family other than the employee member, and so on; but whatever the reasons for the fact, the fact itself was made abundantly clear in the investigation. Table 2 reveals the extent and nature of this liability.

TABLE 2. DAYS LOST BY EMPLOYEES DUE TO SICKNESS AND ACCIDENTS

Sex and Marital Condition	Days Lost Per Employee on Account of			
	Total Sickness and Accident	Sickness	Industrial Accidents	Non-Industrial Accidents
Married males	5.03	4.45	0.42	0.16
Single males	4.91	4.36	0.32	0.22
Widowed and divorced males	5.94	4.85	0.09	0.99
Total average males	5.00	4.43	0.37	0.20
Married females	13.51	13.07	0.11	0.33
Single females	6.87	6.56	0.13	0.17
Widowed and divorced females	12.48	10.47	0.00	2.00
Total average females	8.73	8.35	0.12	0.27
Total married	6.73	6.18	0.36	0.19
Total single	5.83	5.39	0.24	0.19
Total widowed and divorced	9.11	7.59	0.05	1.47
Total average	6.31	5.79	0.29	0.23

Studied by age groups, male employees were found to lose on account of sickness and accident on an average of five days a year, whereas females lost approximately 8¾ days. Below the age of 40, the time lost by males was found to be lower than the average male disability for all ages. Beyond the age of 45, males show a rapidly increasing sickness rate. In the case of females, the morbidity rate remains less than the average up to the age of 30, while beyond that age the rate increases. From an employment standpoint, then, we

might well give careful consideration to women over the age of 30, and to men over the age of 40.

Absenteeism by nationalities was studied, and it was found that American-born tended to lose less time from sickness and accident than most of the other nationalities. The trouble with the present figures on this point,

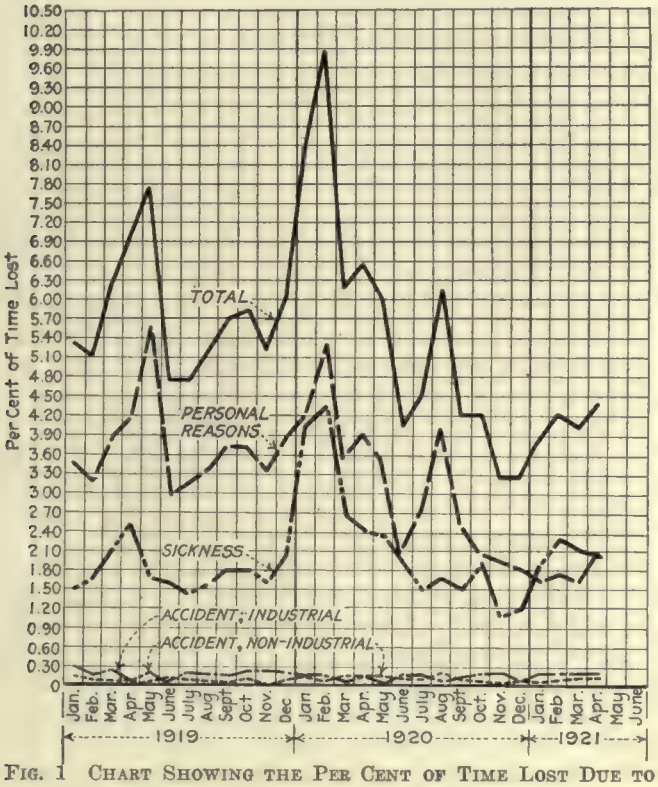


FIG. 1 CHART SHOWING THE PER CENT OF TIME LOST DUE TO SEASONAL VARIATIONS IN ABSENTEEISM

however, is that certain of the nationality groups were so small that their size tends to discount the reliability of conclusions drawn over a short period of time.

Absenteeism due to sickness and accidents varies with a fair degree of regularity according to the day of the week, being somewhat higher at the beginning and end of the week than in the middle, as shown in Table 3.

SEASONAL VARIATIONS IN ABSENTEEISM

As shown in Fig. 1, the seasonal variations in absenteeism from morbidity, personal reasons, and accidents, follow practically the same curve. During the months of March and April, 1919, the sickness rate showed a considerable increase above the average, due to a large number of influenza-pneumonia cases. During the first five months of 1920, an abnormal sickness disability rate due to the second year of the epidemic and to complicating diseases was indicated. In the winter of 1921 there was a slight increase in the sickness rate which could be attributed to no particular epidemic, but was probably due to the natural increase in sickness during the winter months.

As already stated, the high rate of absenteeism because of personal reasons conforms to what might be expected, namely, increases during the spring and late summer and during the abnormal weather conditions which prevailed in the latter part of January and the month of February, 1920. On the other hand, the rapidly declining personal reasons rate which began in the fall of 1920, is attributable to a reduction of the force. Absenteeism declined as jobs became fewer. Moreover, many cases of absenteeism because of personal reasons are due to sickness in the family which necessitates the employee's absence from work.

The correlation between the rise and fall of disability on account of accident and disability on account of sickness is interesting. It may indicate that the conditions which cause sickness disability also cause accidents; or it may indicate that employees who are physically ill are more apt to be injured than well employees. In the past there has been a tendency on the part of safety and illuminating engineers to place the responsibility for the winter increase in accident frequency on improper illumination. The investigation described would indicate that a study of accident frequency and disability and sickness absenteeism, together with the hourly distribution of accidents, might lead to some constructive conclusions.

Absenteeism because of disease was, of course, also studied but only the major facts can be given here. On comparing sickness records with the classification of employees as a result of physical examination, the least sickness was found in the groups which had been classed the most physically fit. Using the international list of causes of death, the investigation disclosed "general diseases" caused 1.46 days disability per employee, "respiratory diseases," 1.26, diseases of the digestive system, 1.11, and ill-defined unclassified sicknesses, 1.09.

Going outside this group classification, and combining influenza, pulmonary tuberculosis, broncho and lobar pneumonia, pleurisy, and other respiratory diseases, the investigation for 1920 showed that this group caused over 35 per cent of the total disability on account of sickness and accidents combined. Women lost practically as much time on account of influenza, colds, and tonsilitis as men. Disability from pulmonary tuberculosis, rheumatism, and all types of accident was nearly the same in both sexes. From broncho and lobar pneumonia, males lost more than twice as much time as females. Men employees were disabled with in-

TABLE 3. PER CENT OF EMPLOYEES ABSENT FROM WORK ON THE VARIOUS DAYS OF THE WEEK

DAY OF THE WEEK	PER CENT OF EMPLOYEES ABSENT FROM WORK					
	TOTAL		MALES		FEMALES	
	1919	1920	1919	1920	1919	1920
Monday	6.34	5.77	5.11	4.66	8.65	7.82
Tuesday	5.83	5.65	4.70	4.56	7.97	7.67
Wednesday	5.33	5.29	4.29	4.19	7.84	7.33
Thursday	5.30	5.30	4.15	4.16	7.46	7.42
Friday	5.51	5.18	4.11	3.96	8.14	7.45
Saturday	6.03	5.43	4.75	4.32	8.44	7.52
Average	5.75	5.45	4.52	4.32	8.06	7.55

	1919	1920
Average per cent of female absentees	8.06	7.55
Average per cent of male absentees	4.52	4.32
Difference	3.54	3.23

fluenza earlier than the women, but the disability per case was less. Pneumonia, however, disabled men for longer periods than women.

The information afforded as a result of this study is not put forth as a discovery of any new general rules or principles. It is valuable only because it represents accurate data collected in a particular industrial establishment. But to contribute to the general fund of knowledge concerning industrial morbidity and absenteeism, it will be necessary to collect comparable data from many and various industries. Throughout the study it was clear to the investigators that a great deal of the information secured would be of value only after a long period of time, and that much other data would be of use only because of its negative nature.

Personnel management *658.4*

Responsibility for Destiny of Product

By SIDNEY BLUMENTHAL

President, Sidney Blumenthal and Company

IN recent years the trial balance sheet of many a corporation, when financing its needs, shows a considerable sum on the asset side under the heading of "Good-will." This intangible and yet widely recognized value stands for what? It does not mean personal affection by someone for the corporation. It does not mean a readiness to wink at its misdoings or errors. It does not even mean a preference, unselfish or kindly, for it because of its old age or tradition. Quite the contrary. Good-will can be translated as the recognition by a large part of the public of the sound principles which underlie the business methods of a concern whenever and wherever these principles are manifest: keeping the bargain, making good the promise, delivering money's worth, dependability in quality, excellence in kind or merit in service—all these items if repeatedly and continuously found present, will subtly and unconsciously build up a faith which is not easily upset by a new claimant who has not yet made good.

Business Must Be Frank in Its Methods

It is, therefore, the policy of successful business today to be so frank in its methods as to bring about with the utmost possible speed, and to retain forever after, this faith and confidence of the customer. And now business has gone a step further in reaching that goal. Not only salesmen and executives, but the entire factory personnel, are, in many institutions, and they should be everywhere, impressed with the new relationship between the firm and the customer. Stability of employment, good wages, or progress of any kind depend on the effort to understand this. Among the slogans adopted by the employees of a certain New York company there are two which reflect the recognition of this idea in the factory organization: the one is "We Are Building an Army of Satisfied Customers," and the other is, "The Customer Is One of Us;" while in a certain large western plant making well-known and well advertised products there is everywhere posted the slogan, "Protect Our Name."

Nothing can more clearly indicate how important is co-operation from the workers in a plant toward good-will in the selling end. It is the good-will in the *manufacturing* end that in these modern days is going to count. We were in danger of getting away from the sense of responsibility and care with which the craftsman in the days of handwork fondled and repolished his product before he gave it over. If we want care and interest in machine-made products, we must bring back and build up that sense of responsibility which the artist or craftsman has for his handiwork.

How Can a Sense of Responsibility Be Created?

How can we build up this sense of responsibility? Of course by education, that is, by imparting the necessary knowledge to all who are connected with the institution. It is not enough, however, to teach them the job or to demand certain results in quality or quantity. You must in addition take your men into your confidence. It is necessary to show them their progress or retrogression—to make clear the effect which bad or good work has on business—to observe the degree of promptness and exactitude with which commitments are met. The laws of trade and commerce, while intricate, can frequently be analyzed and made clear to everyone in the plant, enabling them to meet and overcome difficulties by joint effort. The spirit of ambition on the one hand, and economy on the other, must be continually, though secretly, fired by keeping before every worker the larger business problems which face the company. Advice and help should be welcomed from every one, suggestions for improvement invited, and recognition of merit and helpfulness be prompt, even though it be merely by a word of commendation. To awaken the instinct of the artist creator in some, and the practical sense of the engineer-mechanic in others, is the task of a successful corporation whether it employs hundreds or thousands of men.

It is this sense of responsibility which, when awakened, makes not only the good workman, but the good citizen. If we inculcate the habit of care while at work and an interest in the further destiny of the product, we cannot help building bigger minds in the men. The spare hour in the evening or the morning will not be wasted—the newly aroused feeling of accountability will not permit it to be wasted, and the time, instead of being dissipated, will be spent in healthful diversion, self culture, or constructive activity in the home.

The dollar earned with the consciousness that it is bound up with genuine service will not be so freely—often so frivolously—spent. We *owe* something to the dollar which is intelligently earned. It requires to be *intelligently* spent. It also must render service to its owner, of a kind that is permanent and enduringly satisfying. The sense of the Capitalist—with his responsibility and his obligations to safeguard the stockholders—is therefore awakened in the worker, just as the sense of guarding the standard and progress of every phase of the workman's life and his workmanship is obligatory upon the employer.

Bound up with this viewpoint is the pressing question of the present hour: that of unemployment, or

irregular employment. Workers must know, and have a right to know, why employment either ebbs or comes rushing in without warning. It is proper that they be aroused to the economic failure reflected in unemployment, a failure which is plainly traceable to inadequate business judgment and business methods.

A KNOWLEDGE OF BUSINESS NEEDED

There should be a crying demand for a better survey of business. Business is not adequately chartered. For want of right charts progress is uneven. Individual business organizations make charts and records for comparison or guidance, but there has been no adequate, comprehensive, national effort to chart aggregate, actual consumption at the retail end and compare it with actual aggregate production.

Better knowledge and full publicity of these vital trade facts would prevent overproduction in response to a merely temporary demand. Parallels of production would be seen to keep pace with consumption much more than is manifest on the surface in hysterical boom-times. In this way unnecessary rises, derangement of living costs, wage unsettlement, and eventual overproduction through a stimulus based on imaginary needs and values would be prevented. If these inflations can be controlled, it is a logical consequence that by the same method excessive depression can be avoided. What is needed is a "Federal Reserve Bank" of the economic facts affecting our individual and collective industries.

KNOWLEDGE OF FACTS BEGETS CONFIDENCE

I believe that together with the natural results that came with the crumbling of the economic card house, a paralyzing fear has eaten into the bones of many men, and this holds back the recovery which would otherwise accompany the establishment of newer and sounder foundations. Nothing so begets confidence as a complete knowledge of the facts that results from a complete survey. If every organization of manufacturing trades were fully familiar with the total output in their line of business, as well as with the actual consumption at the retail counter, and if they had at the same time a knowledge of the inventories everywhere on hand, it would be almost a matter of mathematical certainty to tell when recovery would occur in any particular industry.

Intelligent discussion of business problems with our employees involves the knowledge of economic facts such as those mentioned above and many others. Properly given out, such knowledge will widen the horizon, the viewpoint, the character, the flexibility and the capacity for service and co-operation of every employee and executive thus influenced. It will go far to remove the charge of dulness and drudgery with which much in industry is now reproved. It will make for a large increase in that finest output of American industry—upstanding, loyal, progressive, thinking men and women. The production of such men and women can and ought to be the objective of every manufacturer, and it should be, as it is professed to be, the purpose of every labor organization as well. If you wish to call it a personnel problem, well and good. After all, it is the biggest problem that the world has to face. It is a world problem. In conclusion I cannot do better than to quote from a recent address dealing with international relationships made by that eminent American, Elihu Root. We may well appropriate his words and apply them to our own national economic problems:

> This will be a long, slow process. It is not merely difficult to assimilate knowledge into millions and millions of minds of all degrees of capacity, but it is the slow, difficult task of molding character, for it is a matter of character as well as a matter of knowledge.
>
> Human nature does not change but human standards of conduct change, and among the plain peoples of the earth, if we are to attain peace and justice, standards of conduct must change. It is a matter of growth.
>
> How can this be done? How can this mighty change be brought about? Well, by education; but how to educate those who are blind, who cannot see? The deaf who cannot hear, how can they hear?
>
> That is what you must be doing. It is probably not so much the way of new things, but putting into good, intelligent form the old things which you knew before you came here. We must say them so that the plain people can hear, will hear. That is the thing which we must be doing, and it is a great service.

Personnel activities. Cost *658.44(002)*

The Cost of Employee Service

By MARC L. PARSONS

WHAT should the personnel activities—the welfare, the safety promotion, the recreation work, the housing, etc.—cost in a business? How should an appropriation be made, and after the appropriation is made and the money is spent, or being expended, what kind of a check-up system should be devised to determine the results?

Such questions as these are most important, but though the writer has put them to a number of men in charge of the personnel activities of various leading companies, so far he has received only the one answer: "We decide that such and such an activity should be promoted and then appropriate enough money to carry it out, but we have no measure by which we check up results."

The Industrial Commission of Ohio has figured that for the creation of funds sufficient to provide medical attention, hospital facilities, $15 a week for lost time, a set sum for the loss of a limb or member, and another set sum for all lives lost due to accidents, the following appropriations are necessary in the industries named:

$1.80 per $100 of pay-roll in Ice-cream manufacturing
$1.85 " " " " " Packing-house operations
$2.50 " " " " " Steel works operating
$3.20 " " " " " Blast furnace operating
$5.40 " " " " " Saw mill operations

Statistics of a similar nature are given in Bulletin No. 7 of the Bureau of Safety—Sanitation and Welfare of the United States Steel Corporation. They show that in 1917 the Corporation paid $347,370,400 in wages and $10,648,980.26 for welfare and safety work, and to provide relief for injured men and the families of men killed. A portion of this sum was also applied

toward pension payment, and for use in connection with the employees' stock subscription plan, the detailed amounts which were set aside for each such purposes being according to the above-mentioned bulletin as follows:

Relief for Injured Men and the Families of Men Killed	$3,171,994.88	(Approx. $0.91 per $100 of pay-roll)
Accident Prevention	998,806.94	(Approx. $0.23 per $100 of pay-roll)
Sanitation	2,406,951.68	(Approx. $0.69 per $100 of pay-roll)
Welfare	1,652,956.42	(or $0.48 per $100 of pay-roll)
Pension Payments	712,506.65	(Approx. $0.25 per $100 of pay-roll)
Additional Benefits	30,763.69	(Approx. $0.01 per $100 of pay-roll)
Toward the Creation of a Permanent Fund	500,000.00	(Approx. $0.14 per $100 of pay-roll)
Employees' Stock Subscription Plan	1,175,000.00	(Approx. $0.33 per $100 of pay-roll)
Total Expenditure	$10,648,980.26	(Approx. $3.065 per $100 of pay-roll)

Going back to our first question, however, after we have figured what it should cost to conduct the welfare and safety work, how are we to check up so as to know that we are getting adequate, or fairly adequate, returns for the money expended? Some companies consider the good-will of employees gained as sufficient. But how is a concern to know that it has the good-will of its employees? Some of the steel companies used the steel strike as their measuring-stick and decided that the little good-will gained did not justify the expense involved. The record of turnover might also be used as an indicator, but turnover arises from so many causes that it should not be used alone.

How Costs Are Determined

In order to discover what the expense of personnel activities should be, and how the owner of a small business may fairly determine whether or not he is getting his money's worth, let us take as an example a plant employing 500 with a pay-roll averaging $5 per day, per man. Using the figures quoted above, an appropriation of $3.065 per $100 of pay-roll will give approximately $2000 a month to be used in improving the condition of the workmen. With this sum in hand one of the first items of expense will be for a director, and, as in other departments, a good director will be the cheapest in the long run.

But even after securing a director the management must assure itself that it is getting results, and this it will be able to tell in a general way from the spirit among the men. An actual test can be made in checking over the compensation records and costs. Practically all state industrial commissions have figured out just what allowance per $100 of pay-roll is necessary in each industry to pay the expense connected with accidents. If the owner or manager of the industry wishes to check up his safety promotion work he can readily do so by comparing what his accidents actually cost in comparison to the figures compiled by the state industries commissions of his own state. If his "experience" plus his cost of safety promotion is considerably below the rate of $100 of pay-roll as given by the state as the "experience" of others in his line of business, the management can safely conclude that the personnel department is earning some money for the company and saving some suffering among employees. If after a sufficient period has elapsed men who have been buying stock begin to buy homes and become settled stable citizens the management can conclude that 33 cents per $100 of pay-roll is well expended. The writer once surprised a Slavish employee in a company having the stock-owning plan for employees in the act of picking a lump of coal from the street and bringing it to his particular stove near his work. The Slav grinned and covered his action with the statement, "I save him 'cause I'm a stockholder."

How Much Should Be Spent for Recreation?

Perhaps the biggest leaks in the effort to "improve the condition of the workmen" come under the head of "Welfare." Under this classification fall all those odds and ends for the expenditure for which the management is more or less vaguely hoping that some return will be secured. The recreation program usually comes in here. Baseball teams are frequently organized and men are given salaries, soft jobs, and any number of privileges to induce them to represent the plant, the result often being that harm instead of good is done. The writer recently heard of one plant that used 6,000 baseballs during one season, or an average of approximately 40 a day for each working day in the baseball season.

A good gage by which to judge the expense of recreation is to check against the expense for recreational promotion the actual numbers taking part in the recreational activities. If it costs our small industry $500 per month to provide recreation, approximately 77 cents per $100 of pay-roll is being expended. If the recreational provisions are taken advantage of 500 times during the month, $1 per entertainment per month is being paid out. If the attendance averages 100 per day for each working day, the cost per entertainment is approximately 20 cents per entertainment per month. On this basis the management can reach a conclusion after comparing costs with results, actual and potential.

A "Yardstick" Needed

The matter of results in relation to the cost of the various personnel activities in different industries will undoubtedly be worked out eventually as the policies of promotion become more similar and a basis of "experience" is developed. When management finds there is a gage by which it can judge the results gained by the establishment of personnel departments it will be vastly more willing to set up the new departments. Whether or not this growth will come about rests, apparently, in the hands of those now engaged in personnel work.

The Essentials of the Simple Weighing Scale

Its Features of Design and Construction and Their Relation To Industrial Weighing

By HERBERT T. WADE

Physicist and Metrologist

FROM a consideration of weighing in general[1] to scales and balances in particular is a natural transition, and interest in weighing equipment can best be aroused by considering its essential nature. We shall do this, however, in an elementary way without going afield into the realm of theory, mathematics, and design.

All weighing depends upon a comparison of two masses, one of which by common consent is taken as a standard, either directly or through its known relation to an accepted standard; weighing can, therefore, be reduced to a common basis. All standards directly

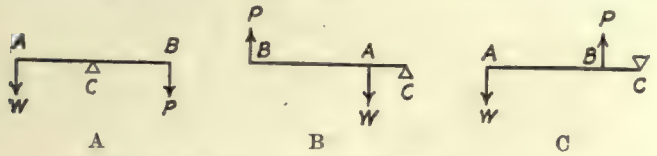


FIG. 1 THE LEVER AS USED IN WEIGHING SCALES

$$W \times AC = P \times BC$$

$$\frac{W}{P} = \frac{BC}{AC} = R = \text{multiplication of the scale}$$

A—First Order Lever. Used in trip scales, postal scales, fine and even arm balances, market scales, weighing beam of platform scales, hanging hopper scales, shelf lever of overhead scales, cross lever in track scales, and center lever in track scales.

B—Second Order Lever. Used in platform scales, dormant scales, wagon scales, and motor truck scales.

C—Third Order Lever. Sometimes used in shelf lever.

or indirectly are referred to one single international standard of mass, the prototype kilogram preserved at the International Bureau of Weights and Measures at Sevres, near Paris, and represented in the United States by kilograms Nos. 4 and 20, accurate copies in the same material, an alloy of platinum-iridium. This standard represents constancy and invariability so far as modern science can accomplish it, and from it by a statutory ratio the customary pound standards of industry and commerce in the United States are derived with high precision at the Bureau of Standards in Washington.

The ordinary user of scales, however, is not and cannot be expected to be interested in metrology, as the science and art of precise measurement and standards is termed; nevertheless he should be expected to know at least his own weighing problems and the apparatus with which their solution is attempted. Such a solution must be supplied by the scale manufacturer, if not by his standard types at least by special designs developed by scale engineers, or in some cases by special equipment produced in a plant itself to meet needs of special routine, test, or sample weighing. Thus in many industries scales and weights graduated decimally in pounds, ounces, or even arbitrary units, not necessarily the metric system, have been built to facilitate testing, comparison, production or other records, accounting, and like purposes.

With the exception of some pneumatic or hydrostatic pressure system and scales where the elasticity of a material is used to measure the force acting, as in the well-known spring scale or balance (in which the chief advantage besides low construction cost is the direct and instant indication of weight by means of a pointer and scale) the main principle involved in weighing is that of the lever. This may be employed either in the form of the simple lever (Fig. 1) or in a combination or succession of such levers, known as a compound lever, so as to have sufficient weight capacity with a reasonable length and arrangement of arms.

In theory the lever is a straight line without mass, moving about a point or fulcrum without friction or resistance. Actually, however, the beam must have mass and its center of gravity will vary with respect to the center of oscillation along with its mass and that of the load applied. In practice the fulcrum instead of being a mathematical point is realized in some form of conical or knife-edge bearing, usually the latter, where a hard and durable material such as steel or agate has its contact or bearing edge ground as sharp as possible so as to rest and move on a similar hard surface with as little friction or resistance as possible, and the same condition is maintained for all the pivots of a scale or balance. Such a knife-edge must approximate a straight line; yet to have sufficient strength to carry its load it must have adequate length and shape so determined as to experience the least possible deformation and wear in service.

METHODS OF SCALE CONSTRUCTION

Besides the knife-edge two other arrangements are used in scale construction, though to a far less extent. First a torsion band, to which the lever or beam is connected and which affords a very delicate and constant pivot (this is employed in a wide range of balances of the so-called torsion type) and second, a flexure plate or plate fulcrum principle, where a thin flexible strip of highly elastic metal forms both the support and the fulcrum or pivot.

For the rapid and accurate weighing of small quantities the torsion balance is employed in industrial work, consisting as it does of a narrow steel band stretched tightly over a frame, to which at the center the beam

[1] See article, "The Essentials of Weighing in Industry," in MANAGEMENT ENGINEERING for September, 1921, pg. 129.

is clamped while at its ends the load-carrying devices are clamped to similar torsion bands. The beam truss in the form of a parallelogram thus is capable of movement at the corners. Two forces, gravity and torsion, in continual opposition act on the beam and its load so that it is very sensitive to small differences of weight in the two pans. With the torsion balance, in addition to its durability and constancy, a leading advantage is the ease and rapidity with which it may be used in fine routine weighing. Hence, it is employed extensively in textile industries, as in connection with a drying oven where the moisture of yarn is determined, and in such measurements as that of the weight per yard of a fabric based on the weight of a 2-in. square sample.

Of the factors influencing the performance characteristics of a scale as outlined in Table 1, accuracy is naturally the first. This primarily depends upon the correctness of the leverage ratio or multiplication and also upon the accuracy of the counterpoise weights. In the design the lever ratio is figured upon the capacity and sensitivity desired as well as the special features of use and installation, considering the probable range of use, average load, counterpoise weights, and other adjuncts. Naturally the smaller the multiplication the more accurate the reading, as errors of levers and counterpoise weights are correspondingly magnified. The multiplication must be distributed through the lever system so that the weight shall be proportionately borne by parts of adequate strength.

The length of the lever arms, or concretely the distance between the knife-edges of each lever, is especially important, for any error or even a small change in this distance through wear, rust, abrasion, or otherwise, will have a serious effect. Therefore, it is desirable to have the distances as long as possible between knife-edges so as to affect the ratio as little as possible by changes, and at the same time to have a knife-edge of sufficient length to produce a low loading stress per unit length, thus reducing to a minimum the change in distance through wear.

The constancy of a scale depends upon the size and material of the parts, especially those subject to wear, such as the pivots, knife-edges, bearings, loops, etc. Wear on the knife-edges or bearings, or overloading of the beam or any lever beyond the elastic limits will produce changes in the effective lengths of the lever arms or increase the friction at the knife-edges or pivots. Adequate strength of parts and care in construction naturally increase the cost of a scale; but it is money saved for the purchaser, as a worn or dull scale usually weighs light.

The capacity of a scale depends upon the size and material used in the construction of the moving as well as supporting parts. The function of a scale is to support a moving load without developing any stress on the levers or other parts that would affect either their integrity or relative position, and consequently it must be designed for adequate strength at maximum capacity with due regard also for possible overloading, for it is inevitable that by accident or design loads far in excess of those contemplated or ordinarily weighed will be placed upon it.

If a scale does not respond to a small variation in the load as shown at the indicating device and within approved limits, it naturally fails in accuracy as to the weight returned. Such variation usually is expressed in terms of the distance moved by a pointer or at the trig loop on the end of the beam of a platform scale. This indicates for a unit change of weight the degree of the displacement of the lever system, or conversely for unit displacement the amount of weight causing it. Hence arises the term used in scale practice, "sensibility reciprocal," defined as "the weight required to move the position of the beam, pan, or pointer, or other indicating device of a scale a definite amount at the capacity or at the lesser load, the effect of friction in causing inconstancy of this position being eliminated."

Sensitiveness is affected by many factors to be considered in the design of a scale and its levers, but speaking generally greater sensitiveness is secured by increasing the length of the beam, decreasing the mass of the beam, lowering the center of gravity of the beam below its point of support, decreasing the multiplication or ratio of levers. The foregoing will appear evi-

TABLE 1. FACTORS INFLUENCING THE PERFORMANCE CHARACTERISTICS OF SCALES

ACCURACY	CONSTANCY	CAPACITY	SENSITIVENESS	QUICKNESS
Depends upon the multiplying power of the levers being as assumed (to be determined by accurate sealings and test) and accurate counterpoise weights.	Depends upon size, shape, and material of parts: ability of knife-edges and bearing surfaces to withstand wear and rough usage.	Depends upon strength of levers, knife-edges, bearings, and supporting systems, including foundations.	Depends upon the elimination of friction in order to produce a low sensibility reciprocal (see definition).	Depends upon design and construction.
Is secured by good design and good construction.	Any change in relative positions of center of gravity of a lever with respect to the center of rotation due to wear or otherwise tends to make scale less sensitive.	Involves proper size and material of parts.	Results from: Increased length of beam. Decreased weight of beam. Decreased distance of center of gravity below its point of support or knife-edge. Decreased multiplication of beam.	A beam with a small period of vibration and consequently less sensitiveness saves time in waiting for beam to come to rest.
	Is the result of good design and use of good materials.		Above indication for beam but applies to all levers in system which must be properly designed.	In automatic scale depends upon adequate damping system.

dent for a single beam, and of course in a compound lever the effect naturally is cumulative.

Quickness of operation results from good design of the scale to secure proper distribution of mass in the moving parts. The oscillation of a scale lever system at or near equilibrium is much the same as that of an ordinary pendulum, and it is necessary to decide between increased sensitiveness, as indicated by a longer period of oscillation, and the shorter time required for the beam to come to rest. Obviously lowering the center of gravity increases the period of oscillation.

The sensitiveness of a scale should be adjusted with a view to its probable accuracy and the fineness of its graduations. In a platform scale the weight represented by two of the minimum graduations on the beam, or one division on the dial of an ordinary scale, is the maximum for the sensibility reciprocal, as the reading of the scale cannot be made any closer than this amount of motion of the beam in the trig loop. For example if a scale graduated to half-pound divisions on the beam requires, to take an exaggerated case, an addition of three pounds to move the beam to a position of equilibrium at the top of the trig loop, it, of course, fails in sensitiveness and precision, as one pound at the most should accomplish this result.

The familiar platform scale is employed in one of its many forms where large articles or considerable

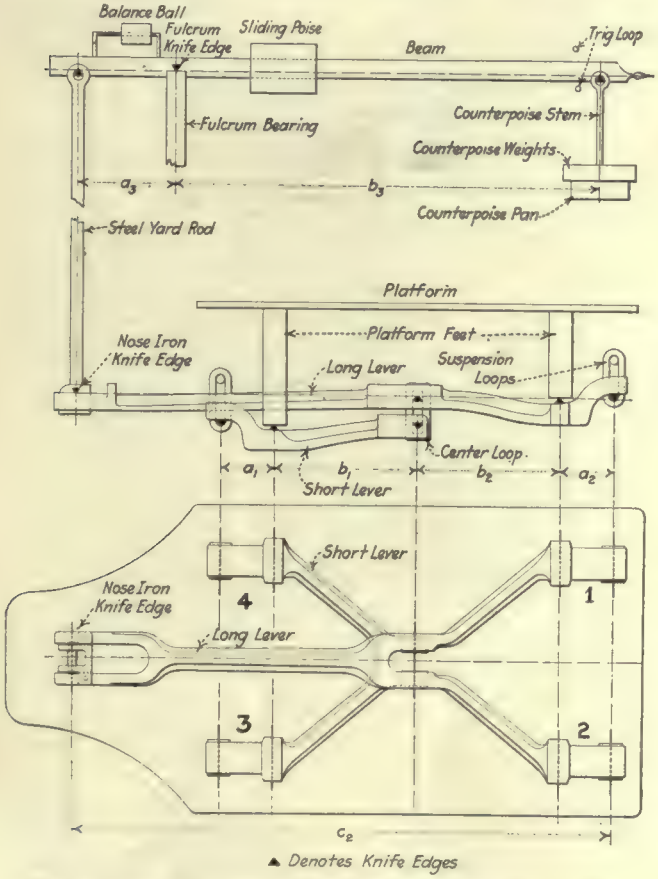
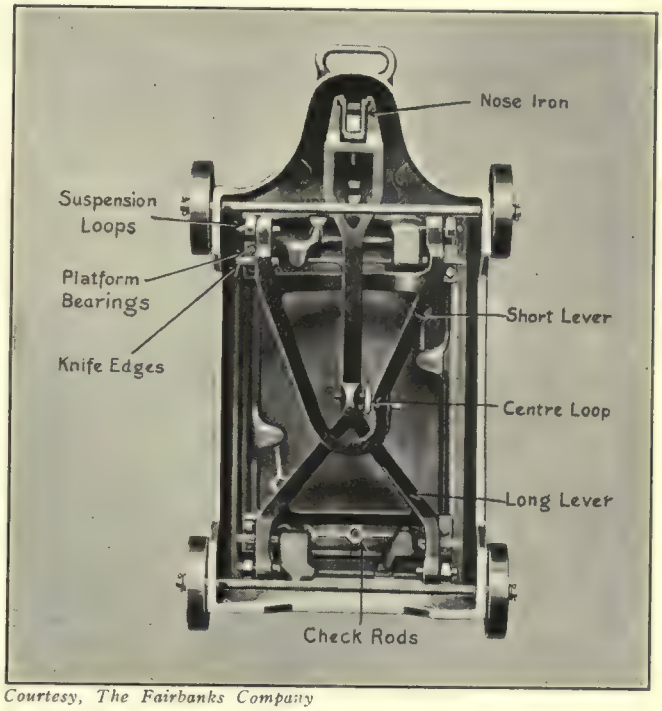


FIG. 2 THE ELEMENTS OF THE SIMPLE PLATFORM SCALE

quantities of material are to be weighed and no unusually high degree of precision is demanded. Essentially it consists of a load-receiving platform carried on multiplying levers which transmit the load to the beam or other reading device. The platform has at least four lines of support comprised in bearings which rest directly upon knife-edges in the multiplying levers. There are, of course, many types and a wide



Courtesy, The Fairbanks Company

FIG. 3 THE PRINCIPAL LEVERS IN A PORTABLE PLATFORM SCALE

range of capacities of platform scales specially designed and made as they are for almost every purpose, but a rough classification would be:

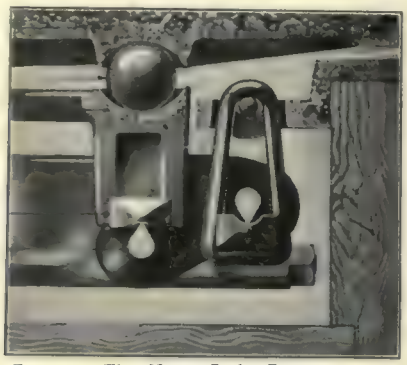
1. Counter Platform Scales, where the reading element is low enough to be observed when the scale is used on a table or counter, and where the capacity is 400 lb. or less.
2. Portable Platform Scales, mounted on wheels or otherwise movable as required.
3. Dormant Scales, permanently installed in fixed mountings within a building.
4. Wagon or Motor Truck Scales.
5. Hopper Scales for bulk weighing in large volumes.
6. Railway Track Scales.

The underlying principles of levers, beams, and knife-edges are common to all, though obviously with increase in capacity must come a greater multiplication in the lever system and a greater number of sections or supporting points where the load on the platform is communicated to the lever system.

Referring to Figs. 2 and 3 with special attention to the four points where the feet of the scale platform rest on the lever system, it will be apparent that, for the scale to indicate the same weight, wherever on the platform the load is placed there must be the same ratio in the two arms of the short lever as there is between the distance from the fulcrum of the long lever to the knife-edges under the platform feet and the distance between the fulcrum and the center loop of the long lever, or

$$\frac{a_1}{b_1} = \frac{a_2}{b_2}$$

In a platform scale the total force acting at the center loop of the long lever would result from the sum of the forces exerted on the four corners of the platform as determined by the ratio of the lever arms. The multiplication of the whole lever system, that is, of the scale, R_1, would be equal to the ratio of the equivalent arms of the long lever, that is c_2/a_2, multiplied by the ratio of the arms of the lever at the beam, or b_3/a_3, which would be $R = \frac{b_3}{a_3} \times \frac{c_2}{a_2}$. This relation is fundamental and unchanging for a scale so long as it remains in the original adjustment and free from the effects of wear. It is secured by placing and adjusting with precision the knife-edges to secure the required distances at the various fulcrums or pivots. Ordinarily in a counter platform or union scale such a multiplication or ratio is either 53 1/3 or 66 2/3 to 1, while in a portable platform scale it is 100 to 1, and in a dormant scale 200 to 1 or more, the counterpoise weights used being marked appropriately 100 lb.—1 lb., 200 lb.—1 lb., or whatever multiple may be used.



Courtesy, The Howe Scale Company

FIG. 4 DETAIL OF BALL BEARINGS AND PIVOTS OF DORMANT SCALE

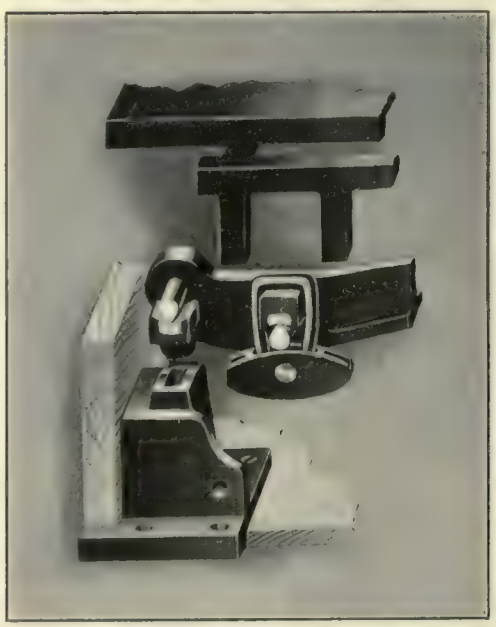
The theory, design, and technique of scale manufacture are outside the scope of the present article, but the general observation may be made that the levers of a scale are so arranged that the transverse knife-edges of any single lever are maintained approximately in a single plane, usually horizontal, with their bearing edges parallel to each other. Also the loops and rods connecting the levers must be parallel and maintained with the connecting lines vertical. If a test with accurate weights shows that the ratio of the arms is not as required then the knife-edges which are set as correctly as possible by gage, must be ground to establish this condition. Naturally anything that either in construction or use tends to alter the proper position or distance of the knife-edges impairs the scales' accuracy.

There are three leading methods of supporting the platform of the scale on the lever system, though, of course, different manufacturers have worked out modifications and refinements peculiar to their product with real or fancied advantages. The platform may rest:

1. Directly on the bearing pivots secured against displacement by eye-bolts known as check rods attached to the frame and loosely connected with the platform.
2. On balls set in a frame bearing on the pivots. (See Fig. 4.)
3. On some form of loop or suspension arrangement where a frame is suspended from the bearing pivots. (Fig. 5 shows one arrangement.)

The drop lever or relieving gear is an important part of the platform scale, being employed to relieve the scale of shocks and jars of impact when heavy loads are deposited suddenly and roughly on, or removed from the scale platform, by disconnecting the lever system when not actually weighing. It may either lower the entire lever system so that it rests on supporting legs at the four corners, or the platform itself may be raised clear of the lever system.

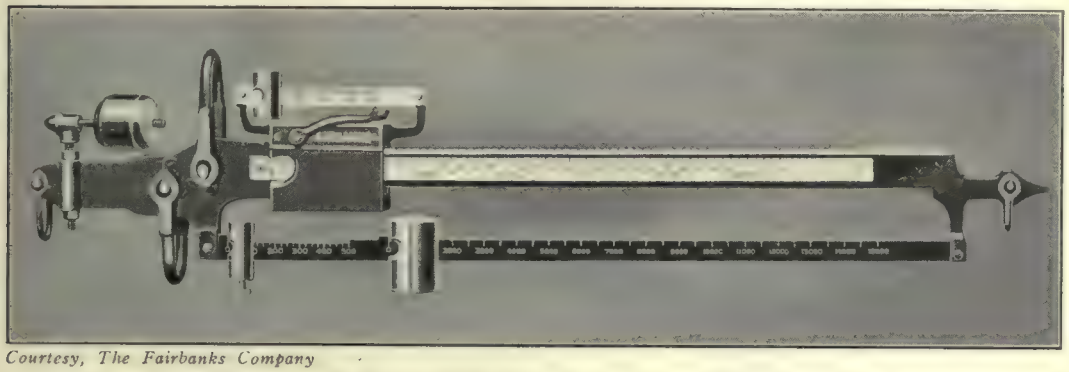
The beam in its simplest form includes a counterpoise pan at the free end and a movable poise to give proportional readings. The beam should balance when there is no load on the platform and the movable poise is at zero. If the load exceeds the indicated capacity of the beam, additional counterpoise weights may be placed upon the pan up to the capacity of the scale. The adjustment of the counterpoise when the beam does not balance with zero load is simply to add or remove the shot or other material contained until the balance is secured, that is, until the beam takes up an intermediate position in the trig loop. Here sufficient space should be afforded to permit of a minimum of travel of 0.4 in. for a beam under 12 in. in length, increasing to 0.9 in. for a beam over 40 in. in length. The arrow beam terminating in a point has certain advantages over the curved or goose-neck beam, where any bending due to accident or otherwise will operate to change the length of the beam and thus give incorrect weights. In place of adjustment at the counterpoise pan a balance ball may be provided at the opposite end of the beam for balancing the scale, its slight movement ordinarily being sufficient to establish equilibrium.



Courtesy, The Fairbanks Company

FIG. 5 SUSPENDED MAIN BEARING OF A PLATFORM SCALE FOR WAREHOUSE, SHOWING BEARING BLOCK, LEVER, AND REMOVABLE PLATFORM

Assuming the correctness of the multiplication the highest accuracy in the use of a platform scale is secured by using accurate and graduated counterpoise weights, but this is offset by the time required to manipulate the various weights, the tendency to error in summarizing the total of the weights employed, and the possible inaccuracy of the weights themselves due to wear and damage. If a single sliding poise and full capacity beam is used it is easier to maintain invariability of the counterweights, but the poise itself must



Courtesy, The Fairbanks Company

FIG. 6 A FULL CAPACITY BEAM WITH MOVABLE POISE AND FRACTIONAL AND TARE BARS

be accurate and also the graduations of the bar. A combination of both methods or two or more sliding poises on auxiliary or fine reading beams is often employed, there being a wide variety of such arrangements. Furthermore, the beams may be provided graduated in any desired conventional units, such as kilograms, bushels of grain, gallons of water, etc.

As many as six or seven different beams may be used when it is desired to weigh material from different sources, and in case of secret mixtures the poises can be locked at desired points within a closed case and the separate adjustments made simply to balance.

The counterpoise weights must be accurate and invariable within the required tolerance, and the effects of small errors must be realized. For example, in commercial avoirdupois weights for a 1 lb. counterpoise weight the tolerance when designed for an even arm scale would be 10 grains, when used with a multiplying lever scale having a ratio of less than 100 to 1; 6 grains is the tolerance, for a ratio of 100 to 1 and less than 1,000 to 1, it is 4 grains, and for over 1,000 to 1 it is 2 grains. Furthermore the tolerances on new commercial weights must be not greater than one-half of the values here given which are taken for a single denomination from a full table.

COMMERCIAL COUNTERPOISE WEIGHTS

The United States Bureau of Standards has divided into four classes on the score of accuracy the various weights designed for commercial purposes as distinguished from those intended for the more precise weighings in scientific and technical laboratories. These are known respectively as Classes A, B, C, and T, ranging in order from Class A, standards available as primary state standards for which official certificates are issued, to ordinary trade weights which are correct within the limits set for commercial standards and use. Each of the first three classes includes weights that are suitable for testing the weights of the next lower class.

Class C weights are usually of one-piece construction with an adjusting plug inserted under specified conditions. These are the standards for local sealers to be used in testing trade weights and weighing instruments. They also find extensive application in commercial and industrial work, where weights of superior grade are required, and they form the reference standards employed in the ordinary plant.

Every weight used in weighing should come within the liberal and practical tolerance of Class T, specified for the ordinary weights of commerce and industry. Specifications for such weights were set at the Eleventh Annual Conference of Weights and Measures of the United States, 1915, and have been officially recommended by the Bureau of Standards, and in several states have been written intact into the weights and measures laws. It is with such accuracy that the average user of scales is concerned, and the tolerances taken as examples were derived from the table in the specifications which take into consideration scales of different multiplication of levers.

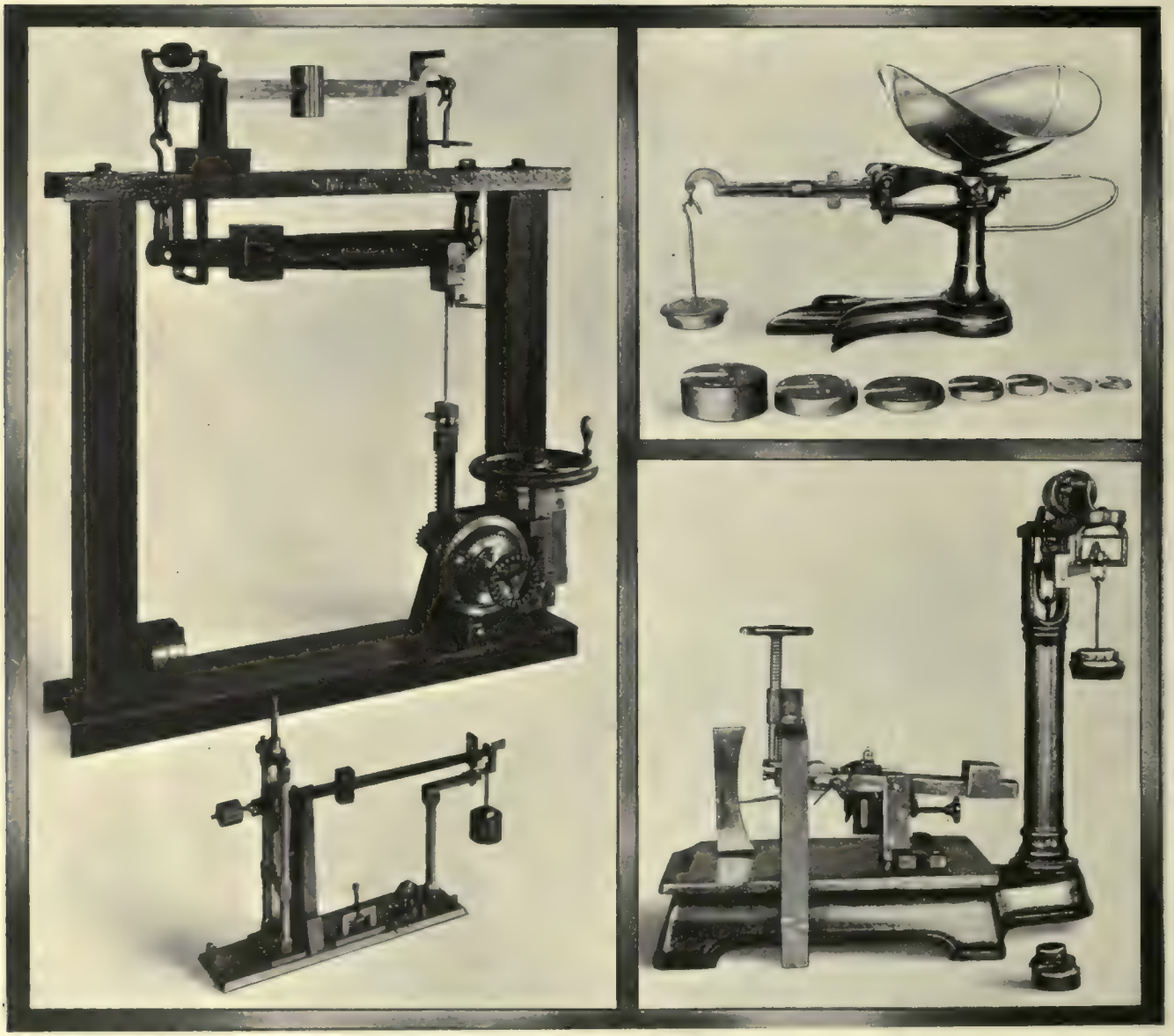
THE DORMANT SCALE

The dormant scale is one form of the platform scale that finds extensive use in industry, and under varying conditions of service. There are different arrangements of levers and there are different degrees of accuracy demanded. To get the required capacity and sensitiveness the scale must be designed with its probable service in view, but strength and robustness are prime considerations. The foundations and the supports must be carefully installed by competent scale mechanics or under the supervision of scale engineers, and be anchored firmly either to piers or walls or to the structural beams.

The duty of a dormant scale may range from the roughest weighings to those made in copper, brass, or other metallurgical plants where large masses are weighed with such precision as to have the results check with the laboratory analyses. Such plants really were pioneers in the precise weighings of large amounts. In one case after inaccurate and unsatisfactory weighing with the usual type of commercial scale, a scale manufacturing company was given practically *carte blanche* to produce a machine of precision for plant use. This was done, and in turn was followed by a second of similar character to checkweigh the loads from the first, both being maintained constantly at a high degree of accuracy and sensitiveness and given a daily test.

From instruments that measure the strength of a fiber to those that determine the resistance of a structural column or the breaking strength of chain cable, there is a wide range of apparatus whose readings must be made on the same basis as those of weight, or at least reduced to them, and with corresponding accuracy. Essentially a testing machine involves some mechanical device for applying a graduated force of varying intensity by means of levers, screws, hydraulic pressure, or otherwise, and some scale or other weighing arrangement is necessary for accurately determining its magnitude at any particular instant and particularly at some critical point as of failure or rupture.

A common feature of such machines is the great strength of the beam and the adequacy of the pivots or fulcrums, and at the weigh beam the same accurate counterpoise weights must be used as are required in any other precise weighing of large amounts. As the test pieces become smaller many of the testing machines suggest in appearance the platform and other scales with the same general arrangement of weigh beam. They have, however, some special device for the test samples and the reading of the results. The testing machine for cement briquettes recalls the familiar platform scale, while the same is true for other machines. Pendulum scales are used in many cases and tests are made of a wide range of materials from fibers to steel. Tests include impact, elasticity, tensile, and compression strain, shearing, bending torsion, hardness, and other properties. The machines vary as to their application of the force from hand to electric or hydraulic power, but all represent fundamentally a scale with accurately determined standard poise weights and proportioned and graduated levers.



Courtesy, Hollis B. Bagg, Scale Inspector, Scoville Manufacturing Co.

FIG. 7 THE PRINCIPLE OF THE SIMPLE SCALE APPLIED TO SMALL TESTING MACHINES

Upper—A machine for testing the tensile strength of wire.
Lower—A machine for testing springs, either under stress or compression.

Upper—Scale for determining tolerance of finished articles, graduated in both metric and avoirdupois units beam reading to ½ gram and 1/100 ounce.
Lower—A machine for determining the ductility of metals.

The Gantt Chart—III

Its Application to Progress of Work

By WALLACE CLARK

Consulting Management Engineer

ONE of the fundamental principles of management was formulated by Gantt when he said: "The authority to issue an order involves the responsibility to see that it is executed." It is obvious, therefore, that when an executive, that is any one who has control over others, has issued instructions that certain things are to be done, his next step is to provide a mechanism which will at all times keep him informed whether or not his orders are being carried out, and if the progress is not satisfactory will tell him the reason why. The Gantt Progress Chart gives this information clearly and concisely and, since it presents the facts in their relation to time, the chart induces action.

Some executives look back over their records at the end of a given period of time, possibly a year or a month, compare actual accomplishment with what they had believed was possible, and conclude that the performance was either good or bad. It is the wise executive, however, who goes carefully over conditions at the beginning of a period, studies the tendencies, and decides then what performance will be satisfactory. This is his plan or schedule. Should there be, later on, a marked change in conditions which it was not possible for him to foresee, he will, of course, make the necessary alterations in the schedule.

In this way the executive relieves himself of the necessity of analyzing records every time a new figure is received, comparing it with other figures and deciding whether it is good or bad. Usually in the rush of business comparison of this kind is likely to be done hastily, and hence the decision is apt to be faulty. Where, however, the executive determines beforehand what will be satisfactory to him, he is almost sure to study the matter thoroughly in the first instance and to secure all the expert advice and accurate information available. After this schedule is worked out, a comparison of accomplishment with the plan becomes merely a clerical task; the executive's time is saved and he is left free to study the tendencies and take the action indicated by the records.

The Value of the Gantt Progress Chart

In this phase of an executive's work the Gantt Progress Chart is of inestimable value. Its use makes a definite plan necessary and presents that plan so clearly that it can be readily understood in detail and as a whole by the executive's associates and subordinates. It compares the performance with the plan both as to time and amounts, and makes it possible for the executive to foresee future happenings with considerable accuracy. It shows what part of the work has been done in accordance with the schedule and emphasizes the reasons why performance has fallen short, thus fixing responsibility for the success or failure of a plan.

Usually it is unnecessary for the higher executive to follow on progress charts all the details of the work being done under his direction, but he does wish to know the progress of the work as a whole, and this may be done by following key operations, typical items, or totals. If the progress made on one of these subdivisions of the work is satisfactory, he will pay little attention to it; on the other hand if another part of the work is behind schedule, he will call for the detail charts in the hands of one of his subordinates. From these records he can see what particular items are being delayed and the reasons. By then concentrating his efforts on that particular problem he can, by reason of his broader authority and greater resourcefulness, overcome difficulties which to his subordinates were unsurmountable.

How the Gantt Chart Saves the Executive Time

This method makes it unnecessary for the general manager of a manufacturing plant, for instance, to go through volumes of reports or to go the rounds of his superintendents or foremen in an attempt to find out what work is not progressing satisfactorily. His subordinates are likely to minimize the importance of some delays, and on certain other items they are apt not to realize the effect which even a short delay will have on other branches of the work. Gantt charts emphasize the fact that time is the most important element in production—they bring to the attention of the general manager the matters which are most urgent and they hold his attention until he takes action and obtains results.

Another advantage of the Progress Chart is that it enables the general manager to know whether or not he will be able to live up to his delivery promises, and a reputation for keeping promises is one of the most valuable assets of any organization. Of course, the ability to make quick deliveries will frequently secure an order which would otherwise be lost, but quick deliveries depend entirely on the volume of work ahead. If a customer is continually promised quick deliveries by a plant and much later deliveries by its competitors, the reputation of the plant will be injured rather than enhanced, for the customer is likely to conclude either that the poor quality of the product prevents the plant from securing orders or that another customer's orders are being set aside for his. One impression is as de-

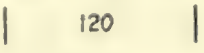
trimental as the other, for the customer knows that if another customer's work is set aside for his, it is probable that his work will be set aside for the next insistent customer.

It is clear, therefore, that a reputation for deliveries must be founded on the ability to live up to whatever promises are made. If a promise of delivery is to be kept, all the work in a plant must be planned so accurately that, when a new order is received, it is possible to tell almost to a day when the work will be completed. The Gantt Progress Chart enables the manager to keep before him all the promises he has made, to concentrate his attention on overcoming obstacles and avoiding delays and, when it is impossible to live up to a promise, it enables him to give the customer advance notice of the fact.

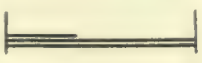
Drawing the Gantt Progress Chart

Angles opening to the right and to the left indicate respectively when the work is to be begun and completed. The amount of work scheduled is shown by a figure at the left of the space and the amount to be done to date by a figure at the right of the space; light lines represent work done during any period of time and heavy lines the amount done to date, as shown by Figs. 1, 2, and 3 in the first article in this series.

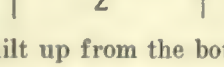
If work is done in a period of time for which no work was scheduled, it is shown by a figure in the middle of the space, thus:



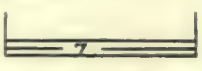
When the amount of work done is more than that scheduled, the light line is drawn across the space more than once, thus:



If no work is done in a period for which some was scheduled, a Z (for zero) is placed in the middle of the space, thus:



These lines are built up from the bottom to emphasize the fact that they belong to the heavy line below them. A chart will look crowded if more than three light lines are drawn, so when the number of lines exceeds three, the figure is shown thus:



This indicates that the work done was seven times as great as the amount scheduled.

The heavy cumulative lines are drawn on the scale of the space through which they pass. Therefore, if the scale of the spaces or periods of time varies, the sum of the light lines may not equal the length of the cumulative line, as is the case in Man and Machine Record Charts.

Broken lines represent work which has been done previous to the date when the chart is drawn. If, for instance, a chart is to show quantities of parts manufactured, a heavy broken line would indicate the quantity in stock when the chart was begun.

In a plant which manufactures only on orders from its customers or its own sales organization, a promise of delivery is usually made on each order and each must be watched to see that the promise is kept. The Progress Chart of Crank Handles (Fig. 16) was drawn in a plant where all orders were charted. The angle opening to the right indicates the date on which the material was to be issued from stores; the figures indicate the dates on which the various operations were to be begun, that is, on the first line of the chart "1" indicates that the first operation was to be begun on January 19, operation No. 2 on the 21, etc.; the angle opening to the left indicates the date on which the parts were to be shipped; the heavy line shows what operations have been done; and the letters under the lines indicate the reasons for delay.

The "V" indicates that this chart was reproduced on March 3. If the work had proceeded exactly according to schedule, the heavy lines would all end under that date except for those orders which were due to be completed at earlier dates. However, the work had not made the expected progress; the third order on the sheet was a week behind schedule, the fifth about two weeks behind, the sixth two weeks ahead, and the seventh ten days behind time.

From this chart the manager could see at a glance which orders were behind schedule. On the fifth order on the sheet, for instance, he could see that the eleventh operation had been begun but not finished, and the "R" showed that the delay was caused by repairs. Reference to the shop order told the manager what that operation was and the department in which it was being done. Over the telephone he found out in detail from the foreman the repairs needed and the probable date when the operation would be finished. The chart showed how much more time would be needed for the remaining operations, so that the manager could take whatever action he deemed wise to rush the work and he could advise his customer as to probable delivery.

Continuous Manufacture

In a plant where articles are manufactured continuously the Progress Chart is, of course, somewhat different from that used in a plant which manufactures on order. The chart of Links Manufactured on Schedule (Fig. 17) illustrates this.

On the first type of link No. 467-BT, it was found that the normal usage based on sales for the previous two years, with more weight given to recent months, was 10,000 per month. The broken lines were the first ones entered on the chart: it was found that about 16,000 finished links were in stock and accordingly a broken line was drawn through the first month and 60 per cent of the second month. It was also found that manufacturing orders were on hand for 10,000 additional links, so a broken line was drawn through an amount of space representing 2.6 months, that is, 1.6 months for the links in stock, which of course had been covered by past orders, and one month for the uncompleted orders. An inventory showed that there were in the storeroom 30,000 forgings besides the 26,000 links in process or in finished stock. Accordingly a line was drawn through 5.6 months to represent 56,000 forgings.

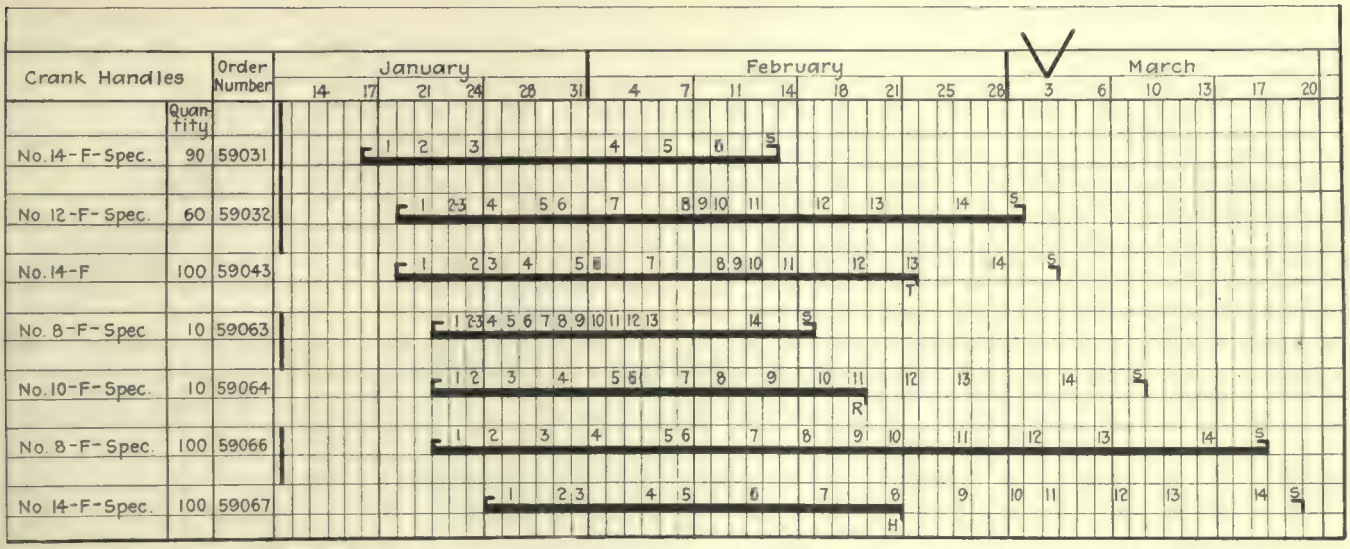


FIG. 16 A GANTT PROGRESS CHART USED IN A PLANT WHICH MANUFACTURES ON ORDER

In this chart the angle opening to the right indicates the date on which the material was to be issued from stores; the figures indicate the dates on which the various operations were to be begun; the angle opening to the left indicates the date on which the parts were to be shipped; the heavy lines show what operations have been done; and the letters under the lines indicate the reasons for delay.

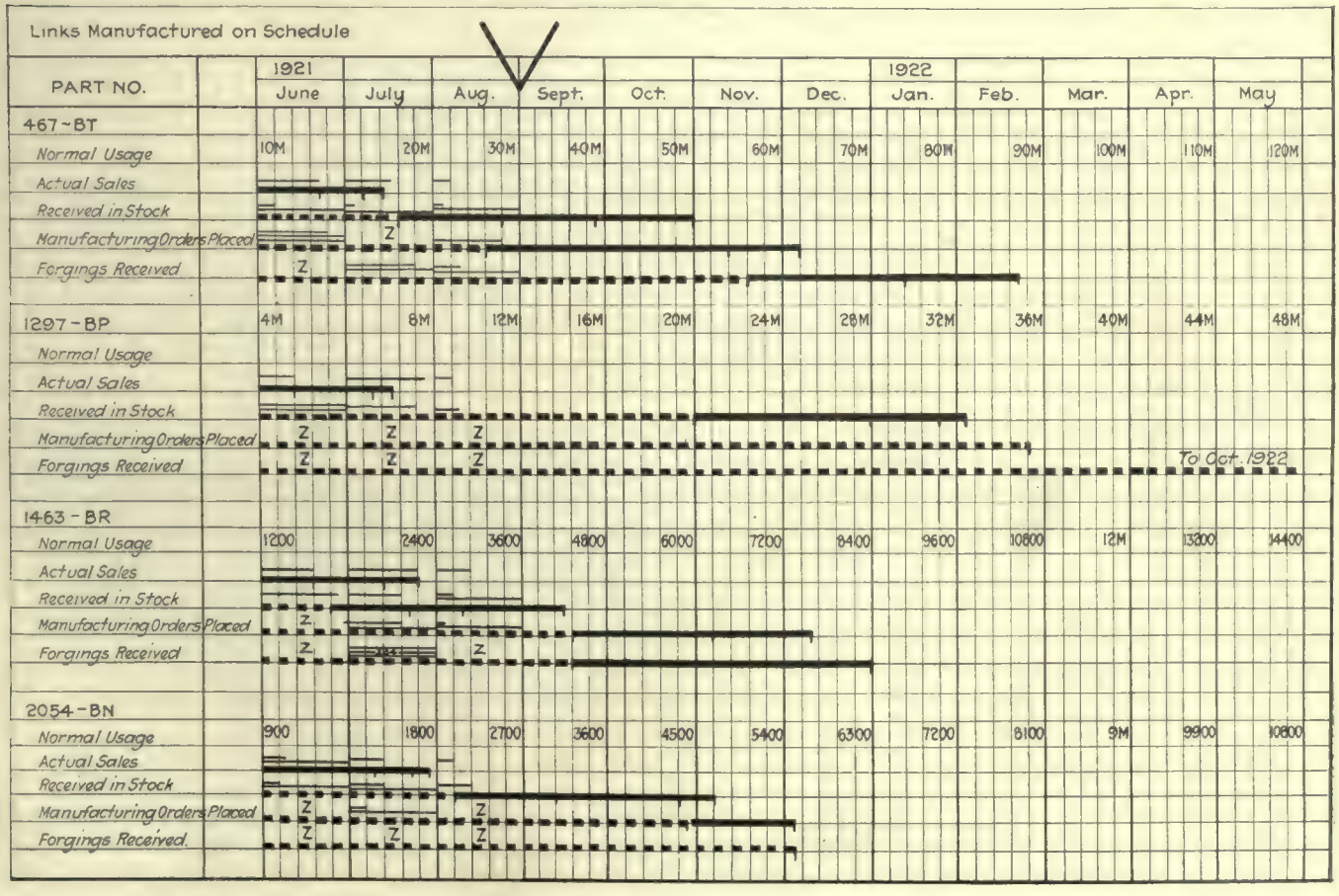


FIG. 17 A GANTT PROGRESS CHART USED IN A PLANT WHERE MANUFACTURE IS CONTINUOUS

LEGEND

10M |	Figure at left of monthly space is amount scheduled for each month.
| 30M	Figure at right is amount to be done to date.
———	Work done that month.
Z ▪▪▪▪	Zero production, i. e., no work done that month.
	Work done before June 1st, when chart was drawn up.
———	Work done when chart was reproduced, August 31st.

During the month of June, 7,000 links were sold and a light line was therefore drawn through 70 per cent of the space, with a cumulative line of the same length. Also 12,000 links were received in stock, so a light line was drawn through 120 per cent of the June space and a heavy line of equal length was added to the broken line. During the same month orders were placed for 27,500 links because the management had decided to other month's supply. It was evident, therefore, that there would be a four months' supply on hand some time in September, and accordingly no further manufacturing orders were placed. It was also evident that there were sufficient forgings on hand so that no further purchase orders were necessary.

On the next type of link, No. 1297-BP, the normal usage was 4,000 per month. When the chart was made

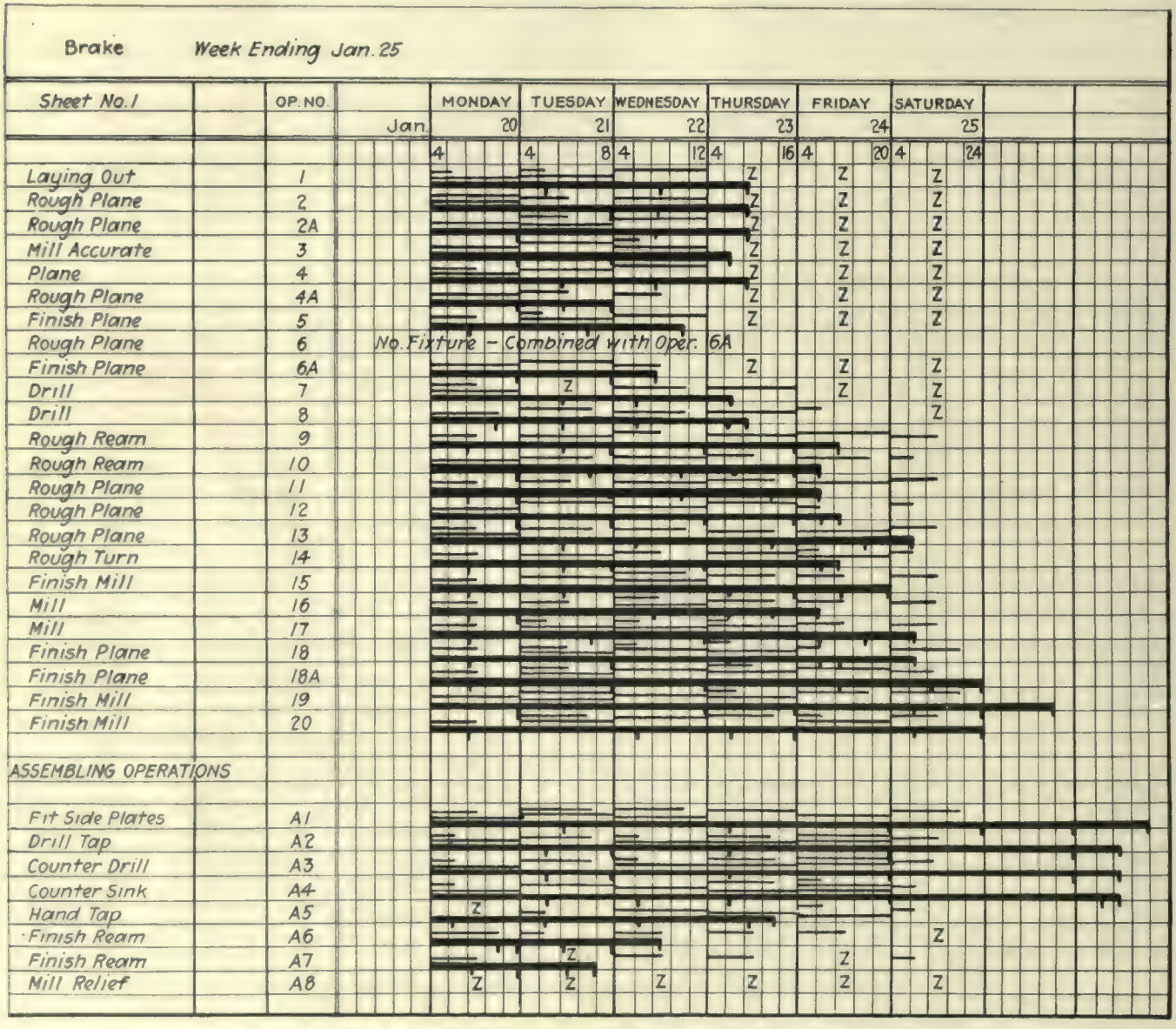


FIG. 18 A GANTT CHART SHOWING PROGRESS OF WORK THROUGH VARIOUS OPERATIONS

build up a four months' stock and after that to manufacture each month an amount equal to the sales of the previous month. No forgings were received that month, so a Z was entered in the space.

During July and August sales fell below the normal with the result that at the end of August, when the chart was reproduced, the difference between the cumulative line representing sales and the one representing receipts into stock showed the amount of links in stock, namely, three and a half months' supply. During August manufacturing orders had been entered which would bring into finished stock during September anup, June 1, five months' supply was already in stock, with manufacturing orders placed for 15,000 more and forgings on hand sufficient to last up to October of the following year. The chart made it clear that it was unnecessary to place additional orders for the manufacture of links or for forgings.

COMPARING OPERATIONS

At times a series of delays occur which interfere seriously with production, but it is difficult to get a comprehensive understanding of the situation from a table

of figures and still more difficult to explain it to some one who is not familiar with the details.

During the latter part of the recent war the Director of Arsenals considered the recuperators, or recoil mechanisms, for the 75mm. field guns the most important work in American arsenals. There had been a

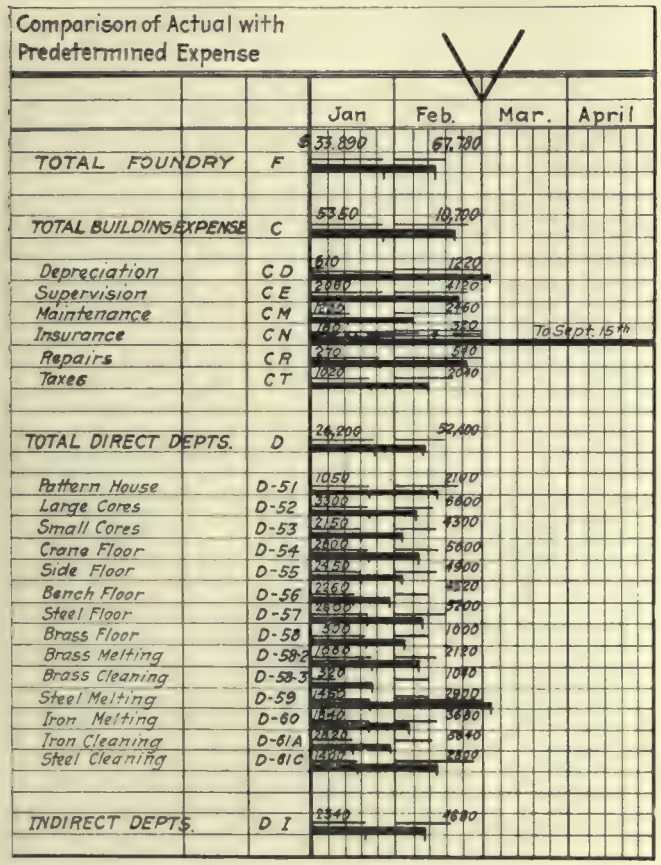


FIG. 19 A GANTT CHART USED TO DETERMINE SHOP COSTS

number of delays on this work and various explanations given, and finally the director asked to have the progress indicated on a Gantt chart. Fig. 18 shows the progress made during a certain week on the framework of the recuperator, usually called the "brake."

A large machine shop had been erected and machine tools installed to manufacture these recuperators at the rate of four per day. The chart shows that on the first operation five were manufactured on Monday and Tuesday, four on Wednesday, and none the remainder of the week. The production for the week was therefore two and a half out of six days. Going through the various operations it was evident at a glance that the principal delays were occurring on operations 4A and 5, planing, and on A6 and A7, reaming. The chart focused the attention of the management on those operations and made apparent to everyone concerned the relative importance of this delay.

BUDGET AND EXPENSES

The ability of an executive is judged to a considerable extent by the cost of the work assigned to him. The best way to control expenditures is to keep continually before those who authorize them a comparison between what they are spending and what they should spend. The Gantt Chart presents such records more clearly and concisely than any other type of chart or any table of figures. A comparison of actual expenses with predetermined expense in a foundry is shown in Fig. 19. The first line indicates that in January the total expenses of the foundry amounted to about 90 per cent of normal and in February 60 per cent. The succeeding lines show which departments have been within the budget and which have exceeded it.

Modern business is so complicated that, unless he takes effective steps to prevent it, the present-day executive will be so overwhelmed by detail as to be unable to discharge the essential duties of his office. Gantt charts intelligently handled will go far toward clearing his desk for action. They will greatly reduce the writing of letters and wordy reports; they will make it easy to discover inaccuracies in reports; they will make clear what is to be done and what has been done.

Since the task of an executive is to get work done and the Gantt Progress Chart compares the work done with what was planned, it is evident that besides its other benefits the chart provides a method of measuring the service rendered by an executive. It is no longer necessary, therefore, to depend upon general impressions in judging the ability of an executive, since by the use of the Gantt Chart executive ability is capable of being fairly accurately measured.

Cost accounting *657.524*

"Depreciated and Obsolescent" Cost Accounting

By G. W. GREENWOOD

Secretary, United Refractories Company

IN addition to those well-known elements of cost, direct labor, indirect labor, raw material, supplies, etc., there has been discovered within recent years by many manufacturers a new element — depreciation; and under the fostering influence of the income and excess profits taxes it has, as Victor Murdock remarked to an assembly of manufacturers in Washington a few years ago, grown very rapidly. Its younger brother, obsolescence, whose legal status has been more recently acknowledged, is following the same development.

In dealing with this item of depreciation, the advice given by cost accountants is somewhat as follows: Estimate the depreciation for a year, divide the result by twelve and include this amount in the cost for each month. The apparent object of this procedure is to equalize the cost of repairs and replacements, by including in each month's costs a fixed amount, instead of simply including each month the amount of whatever repair and replacement bills are incurred. But that this process rests on an unsound basis and has no logical justification, should be readily perceived.

For example, in February, 1921, there were 24 working days and 27 in March. Assuming a plant to run full time both months, the depreciation charge per unit in

February is 12½ per cent greater than in March. The same reasoning applies to all other time-measured elements, such as salaries, fire insurance, taxes and most overhead items. Thus, under the most favorable circumstances, there is a great discrepancy between the costs of two successive months, and in times of keen competition an error in costs of this magnitude may prove embarrassing. Suppose, for example, a brick plant to have an order for special bricks 12 in. long, but that when the bricks were ready for shipment the lengths were found to vary from 12 in. to 13 in. Naturally, the shipment would be rejected. But the manufacturer unconsciously tolerates discrepancies as great as these in the important elements of cost and these faults alone should condemn this system in the minds of thinking executives.

The Results of Such Accounting Methods

In actual practice, however, the results are still more disastrous, for plants do not run full time month in and month out; so that this condition becomes aggravated until costs obtained by this process are hopelessly inaccurate.

For example, suppose that in July, 1920, a brick plant receives an order for some special shapes, amounting to two full days' run. It makes half the order July 31, and the balance August 2 (the first being Sunday). Suppose further that all elements of daily costs for the two days are the same, and that all monthly time-measured costs are the same for July as for August. If the plant runs full time both months, producing the same amount of bricks in each of the two sets of 26 working days, then the cost of the two lots of special bricks will be the same. But plants do not always run full time, so let us consider the effect of the plant's closing down after 13 full days' operation in August. Using the favorite method of concealing costs, which consists in dividing the operating and other charges for the month by whatever happens to be manufactured during the month, we find that the bricks made July 31 are charged with the direct costs for that day, with one twenty-sixth of all the time-measured elements and one twenty-sixth of the costs when the plant is closed down for the four Sundays and the one holiday. The same amount of bricks, made August 2, is charged with one thirteenth of the time-measured elements and of the costs for the four Sundays and the holiday; and as if this were not enough, the unfortunate second lot of bricks bears one thirteenth of the inevitable expense for the 13 working days during which the plant is shut down, an added cost unknown to July's output. Can anything be more unreasonable?

Cost Figures Concerned Primarily With Products

Yet this is only part of the absurdity. At the close of July there were bricks in all stages of manufacture —drying, burning in kilns, and cooling; and so the bricks made during the first half of August bear all the costs of their own drying, setting in kilns, burning, and unloading (assuming that two weeks will cover the process of manufacture) and, in addition, the expense of completing the manufacture of those in process at the close of July. July, of course, did the same for those in process at the end of June, but it left a similar heritage at its close, and so averaged up all right. Thus in the latter case, many important elements of cost are doubled, entirely new elements are introduced, and the use of the all-too-common method of concealing costs results in a gross disparity between the apparent costs of the same quantity of bricks made on adjacent working days. Logically, the costs are the same in both cases, and what is more, a correct method of figuring costs will give the same result in both cases, and it will be somewhere between the two figures obtained by the methods criticized.

Again, while the rated capacity of a brick plant may be 30,000 bricks a day, there are likely to be many cases where it does not reach this number. Suppose 30,000 are produced on Monday, but on Tuesday, because it makes a somewhat more difficult type, the quantity is only 25,000. If the difference in the output measures accurately the difference in difficulty of manufacture, the latter bricks should, and will, show a considerably higher cost. But if the 25,000 made on Tuesday were similar in every respect to the 30,000 made on Monday, then the excess cost should be charged, not against Tuesday's output, but against whatever caused the fall-down in production. The cost figures for the bricks made on the two days should be the same per thousand, where the reduced output is due to causes not inherent in the process of manufacture.

Unfair Results in Cost Finding

So far, we have considered costs solely from the standpoint of accuracy, logical consistency, and for the purpose of determining a scientific basis for making selling prices. But there is in addition an element of ethics and fair play which deserves attention. Operating costs are supposed to be those which are incurred by the plant and for which the plant superintendent is normally held responsible. But suppose the idleness for the last 13 working days in August was the result of no sales, and that the plant superintendent was not supplied with production orders. Should not the excess costs be charged to a non-selling account? Certainly they should not be charged to any operating account for which the plant superintendent is to be held responsible. In fact, brick should not at any time be charged with expenses when the only direct connection between the brick made and the expense incurred is that they were in the same calendar month. For instance, if the lack of orders in August, resulting in the closing of the plant, at the same time instigated a selling and advertising campaign which would bear fruit in September, surely the half month's output in August should not bear this burden. Dividing a month's selling, operating, and other charges by the month's output is good practice in long division, perhaps, but it is not cost finding.

The 100 Per Cent Time Premium Plan

How It Is Applied to the Payment of Wages for Both Individual and Gang Effort

By L. V. ESTES

President, L. V. Estes, Incorporated

DURING the war and up to the first of the present year, the great cry throughout the industrial world was "more production," and those engineers who were engaged in bringing about plant betterments largely concentrated their efforts upon establishing and putting into effect the necessary means for the proper control of materials and production. But in the last few months the economic aspects of the present industrial depression have made strikingly clear the fact that production control alone will not produce all the results necessary to be obtained or the economies which must be effected.

The demand in industry today is not for "more production," but for the "greatest possible production per man," and this will be increasingly the demand for some time to come if production costs are to be cut to the point where industry will be enabled to meet successfully and profitably the very keen competition and increased selling resistance which now exist and which will be even stronger in the future.

Although production control in itself greatly improves conditions, increases production, and decreases costs, it does not offer a definite, tangible incentive to the workmen to exert their best individual efforts, and we all realize, I believe, that the one way to get the best results from any individual is to offer an incentive which will encourage him to greater activity.

Value of Incentive Systems Not Fully Appreciated

Various incentive systems of wage payment have been in use for many years without the value of their principles and their possibilities being fully appreciated by industry. My candid belief, backed up by actual experience, is that up to within the last seven or eight months incentive systems of wage payment have not received anywhere near the careful consideration they should have received from industrial executives.

In my mind, the only means by which maximum production per man and minimum costs per unit can be achieved is the adoption of a practical and simple incentive system of wage payment coupled with an effective control of materials, time, and expense, and the one plan which in the writer's opinion combines all these advantages is that in which the worker is rewarded in direct proportion to his accomplishments by receiving pay for 100 per cent of all the time he saves by his increased efforts.

This plan is known as the "100 Per Cent Time Premium Plan," and its simplicity, practical application, and advantages can best be illustrated by the following typical examples, the first applying to individual effort, the second applying to gang effort.

The Plan Applied to Individual Effort

In a certain machine shop a workman with a guaranteed hourly rate of $0.55 was assigned to a job which called for the processing of a lot of 100 of a certain piece, the standardized operating time allowance on which was 4 pieces per hr. In this shop the working hours were 9 hr. on each of the first five working days of the week and 5 hr. on Saturdays. Because of definite, posted, written guarantees by the management, the workman knew, according to the 100 Per Cent Time Premium Plan which had been installed, that:

1. For every hour he actually worked he would be paid his hourly rate, whether his output surpassed the standard or not.
2. At the end of each job his output would be carefully inspected to determine the quantity of perfect pieces produced, the only item adversely affecting the amount of premium earned being the quantity of imperfect pieces due to defective processing.
3. He would be paid at his hourly rate for 100 per cent of all time saved over standard time allowed after deducting pieces rejected because of faulty processing.
4. He would be paid for all processed pieces failing to pass inspection due to defective material, for which he could not be held responsible.

On receiving his instructions, time ticket, tools, and materials for the job, he noted that 100 pieces were to be made at a standard allowance of 4 per hr., which meant that if he were to meet the standard he must finish the 100 pieces in 25 hr. Knowing that the working day was 9 hr. long, he could easily figure that at the standard rate of 4 per hr., in order to fulfil the requirements he must produce at least 36 pieces a day for two days, and 28 on the third day. He also knew that if he were to earn a premium he must increase his rate of production over the standard, taking care at the same time not to spoil any work, for if he did it would be deducted from his total production, thereby decreasing his opportunities for earning extra money. Encouraged by this incentive his output was as follows:

First day.....	42 pieces in 9 hr.
Second day.....	44 pieces in 9 hr.
Third day.....	14 pieces in 3 hr.
Total production.....	100 pieces in 21 hr.

After inspection the record showed that 95 pieces were accepted, 3 pieces were rejected because of being spoiled in processing, and 2 pieces were rejected because of material defects showing up during processing. In accordance with the company's guarantee he was credited with 95 perfect pieces plus two imperfect pieces due to invisible defects in material, or a total of 97 pieces for which he knew he would be paid.

His actual earned time therefore was easily and quickly calculated as follows: pieces to be paid for divided by standard allowed pieces per hour times his hourly rate; or for that particular job, 97 divided by 4 times \$0.55, or \$13.33. The actual time taken, however, was 21 hr. His standard pay, then, based on his hourly rate, would have been 21 times \$0.55, or \$11.55. As he actually earned \$13.33 because of "beating time" his premium was \$13.33 minus \$11.55 or \$1.78.

At the end of the first day he counted his pieces produced and found that he had made 42. Having already figured that he must make at least 36 if he were to meet the standard for that day, he knew that if the inspector passed all of the 42 pieces which he had made he would be six ahead of the standard production rate. He would have saved 1½ hr. for which he would be paid at his hourly rate, if for some unforeseen reason he did not fall behind in his productive rate or unfortunately spoil a number of pieces before the end of the job.

On the second day he attacked his work with redoubled determination to maintain and if possible increase his lead, and at the end of the day found he had produced 44 more pieces. He saw that he had increased his previous day's lead of six pieces by eight more, and was now 14 pieces, or 3½ hr. ahead of schedule.

On the third day he went at it again with the knowledge that he had only 14 more pieces to make and 7 hr. in which to make them, in order to meet the standard. He did not slow up because he happened to be well within the standard limit, but went at his job with more determination than ever and of his total job of 100 pieces he finished the remaining 14 in 3 hr., or 4 hr. ahead of the time limit. He met with a little misfortune, however, as he spoiled 3 pieces and uncovered material defects in two others which would necessitate their rejection.

The Worker Himself Can Figure His Wages

He knew then that the three pieces he spoiled would be deducted from his total, but the two defective pieces due to faulty material would not be deducted, consequently he knew that if the balance of his output passed inspection he would have 97 to his credit. Knowing that the standard allowed rate of production was 4 pieces per hr., he could readily figure that his earnings for the job would undoubtedly be 97 divided by 4 times \$0.55, or \$13.33.

He also knew that in 21 hr. of actual work he had completed an amount for which the standards allowed 25 hr., and if all pieces had been perfect he would have earned 4 hr. premium. But unfortunately he had spoiled three pieces for which he would not be paid, as his earnings were based only on accepted output.

On the basis of accepted output he could readily figure that his allowed time for 97 accepted pieces at the standard rate of 4 per hr. would be 97 divided by 4, or 24¼ hr. But his actual working time had been 21 hr., so he had beaten the standard by 3¼ hr. and his premium therefore was 3¼ times \$0.55, or \$1.78.

Thus we can see the simplicity of the 100 Per Cent Time Premium Plan of wage payment, its ease of application, its fairness to both employer and employee, the ease and celerity with which it can be understood, and the comparatively few computations required by either the workmen or the few clerks required to handle it. It can also be seen that the incentive or premium earned is an absolutely direct and immediate result of the workman's individual effort, and is directly proportional to his accomplishments.

The Plan's Application to Gang Effort

That the system is as fully applicable to gang work or effort as it is to individual effort is made evident by the following actual occurrence.

In a certain iron foundry the men were paid a premium of \$0.05 per flask produced over certain quantities and in accordance with different patterns. This had proved unsatisfactory to both the men and the company, the output from week to week being very erratic, sometimes high, sometimes low, varying largely with the size and shape of the patterns.

According to the plan in force a premium was paid all molders only, who in this case happened to be machine molders. Consequently dissatisfaction was prevalent among cupola men, core-makers, and foundry laborers, because they received the same pay whether for large or small tonnages, while the 11 molders at times received much more than their regular wages.

The records showed weekly tonnages fluctuating from 18 to 41 tons per week with costs per pound varying from \$0.0234 to \$0.0113 respectively. The weekly average over a period of six months was 34 tons per week at an average cost of \$0.0137 per lb.

The foundry operated five full days of 9½ hr. each and 5½ hr. on Saturdays. On Saturday, however, the tonnage was light, but with nearly the same charging, fuel and power costs and loss of iron for a full day, thereby greatly increasing the cost per pound for that day over the normal 9½ hr. working days during the balance of the week.

As the output was so erratic as to make very uncertain the meeting of manufacturing schedules in the machine shop, and as the machine shop received its entire supply of castings from this foundry, which was a part of the same concern, a change was necessary.

It was decided, after a conference, to abandon the existing bonus methods, which were based on individual parts or weights produced per day, and to substitute in its stead the 100 Per Cent Time Premium Plan with weekly rates based on tonnage produced per week.

An analysis of past performance and maximum daily cupola capacity led to the establishment of a standard rate calling for six tons (12,000 lb.) per day, or 30 tons (60,000 lb.) for a five-day week and 36 tons (72,000

lb.) for a full six-day week, in the latter case Saturday being a full 9½ hr. day, the old 5½ hr. Saturday being entirely abandoned. Furthermore, all foundry employees, including the foremen and the superintendent, were placed under the new or "tonnage basis" conditions, thereby reducing the entire situation to a collective and co-operative proposition whereby it automatically caused each man to do his level best or the entire crew suffered.

The following definite stipulation was made and posted conspicuously throughout the factory:

> For all weights over 60,000 lb. for a five-day week, or over 72,000 lb. for a six-day week (full 9½ hr. on Saturday) each man will be paid 100 per cent of all time savings brought about by any increase in the tonnage over the standard set, such payment to be based on his hourly rate. Inspection will determine the net quality tonnage for which premium will be paid, and premium earned during any week will be paid on pay day of the next week following.

The actual inspected and accepted tonnage for five days during a certain week was 70,586 lb., which was 10,586 lb. in excess of the standard of 60,000 lb. for five days. This was a direct gain in production of 17.6 per cent over standard requirements. Therefore, since it had been agreed to pay each man 100 per cent of all time savings made, each man's pay for that week, based on his guaranteed hourly rate, was increased by an amount equal to 17.6 per cent of his weekly normal earnings.

An Application of the Plan

For example, a certain workman, whose hourly rate was $0.45, worked five full days of 9½ hr. each, or a total of 47½ hr. His normal week's pay was, therefore, 47½ times $0.45, or $21.38; his premium 17.6 per cent times $21.38, or $3.76; and his total pay for the week $21.38 plus $3.76, or $25.14.

This method of computing weekly earnings was applied to every foundry employee, foreman, and superintendent included. Analysis of all previous records showed the following:

1. The output of 70,586 lb. for the week in question was the largest five-day record ever made.
2. Only twice had this record been beaten and then by six-day runs in each case.
3. The daily average for the week in question was 14,117 lb., which was a 24.8 per cent increase in production over the daily average of 11,295 lb. for the 26 previous weeks.

The aforementioned method of applying the 100 Per Cent Time Premium Plan had a great moral effect on all of the employees, spurring everyone to do his best and making the laggards so unpopular that they either automatically fell into line or got out, relinquishing their jobs to men who were willing to work and produce results. Soldiering, carelessness, and absenteeism on the part of any one or several employees adversely affected the quantity of production obtainable and consequently the amount of premium earned. The introduction of the plan has therefore resulted in these three obstructive practices being virtually eliminated from the foundry.

The 100 Per Cent Time Premium Plan of wage payment has clearly demonstrated practical, meritorious features as follows:

The Essential Features of the Plan

The plan requires no great mental effort on the worker's part to figure his earnings. He does not have to bother with percentages, bonus tables, and formulas which give rise in the average worker's mind to the thought that such mechanisms are simply clever devices evolved by the employer by which unfair advantage can be taken of his limited education, thereby holding back from him a portion of his earnings, rightfully belonging to him by virtue of his efforts.

The net effect of such complexities, although psychological, is powerful and the obvious and natural result is loss of interest on the part of the worker, retardation of production and the engendering in the worker's mind of suspicion and distrust of the management which it becomes almost impossible to eradicate.

In addition to the above advantages, the simplicity with which earnings can be computed makes possible the employment of a fewer number of clerks for operating this system than are required by any other plant which uses time as a basis of computation.

Under the 100 Per Cent Premium Plan it is possible to have two workers do a similar operation, under the same standard, with varied earnings, but with similar productive results. This applies especially in the cases where an older employee may receive $0.70 per hr., while a younger employee may receive but $0.55 per hr. An employer is entitled to this profit, and it is certainly justice that the older employees receive preference over the younger ones as to amount of hourly rate, because of their long terms of service, their loyalty to the concern which employs them, their ability to operate most types of machines, and their thorough familiarity with the company's product.

Standards set for the 100 Per Cent Time Premium can remain indefinitely without adjustment, at the same time allowing for the fluctuations of the community wage scale. Standards need adjustment only when the motions of an operation or the methods of processing are changed, due to the introduction of improved machinery or tools, and are so guaranteed in writing.

Fluctuations in the labor market are met by merely changing the basic hourly rates to meet the revised conditions, and no change whatever is made necessary in the standards, thereby avoiding the usual and serious dangers encountered when rates are cut.

The Plan Begets Confidence

The worker is guaranteed a definite hourly rate and a definite day's earnings based on working a normal full working day at his hourly rate. This is very important to learners, as it prevents them from becoming discouraged when they fail to meet or surpass the standards. In addition, the worker is paid his hourly rate for all time saved above the fair and equitable standard which must always be set as the result of

careful time study and operation analysis, taking into consideration all influencing factors. Thus confidence is inspired in the worker, and the greater interest and conscientious effort put forth by him to attain and surpass the standards set naturally result in increased wages, lower costs, and greater profits.

The plan holds back a worker for only one reason, namely, lack of quality production, and this is the only justifiable reason why any worker operating under an incentive or any other plan should be held back. With correctly set standards there is no reason why a worker should not be allowed to produce to the limit of his ability; for the more good pieces he produces in a given time period and the more he earns, the less the cost of the product and the greater the profit to the company.

Any steps taken by the management to prevent the worker from producing more work and therefore earning more money are likely to have an immediate and disastrous effect. Such tactics will absolutely defeat the main objects of the incentive plan as set forth above, and will produce the same dangerous results as would occur if the standards were flagrantly and unjustifiably cut for the sole reason of preventing the worker from earning what might be thought to be "too much money."

Under the 100 per cent Premium Plan no arbitrary monetary penalty is levied against a workman who fails to reach any given standard of performance which has been set. Such a penalty, by virtue of its inherent unfairness, serves only to kill the workman's initiative and desire to strive for greater efficiency. Furthermore, such a penalty as just mentioned invariably reacts on the beginner, who would naturally be the first one to fail to reach a given standard. The only penalty, if it can be properly called such, is that the premium paid is based solely upon the number of perfect pieces produced which pass inspection.

EACH JOB BASED UPON ITS OWN MERITS

The plan deals with the worker's individual accomplishment on each job to which he may be assigned. Such a job is considered as a unit with no relation to any other preceding or succeeding jobs he may be on, and if he earns a premium on one job, he is paid this premium—if he fails to earn a premium on his next job he is paid at his guaranteed rate for the actual hours he worked. Therefore it is evident that if a worker were to be employed on, say, seven different jobs during three normal working days and surpassed the standards set on only three of the seven jobs, he should naturally be paid a premium on the jobs on which he surpassed the standard, while on the others he naturally should receive no premium.

Any averaging of the worker's efficiency over a given period and the paying of premium according to whether this average exceeded the standard or not would be essentially unfair and unjust. The failure to make a premium on certain jobs might pull a worker's average down so low as to nullify the premium made on certain other jobs, thereby preventing him from receiving what was rightfully due him as the result of his efforts. Thus he would be penalized for something for which he might not be at all to blame, namely, an incorrectly set standard or an inherent lack of aptitude for some particular job or jobs.

The plan is just and moral because it violates no right or obligation; it gives to every man exactly his due; it is equitable in action and judgment; it conforms to and is grounded in reason; it is essentially fair and impartial; it is characterized by practical excellence; and it conforms strictly to one's natural sense of what is right and proper.

CASES WHERE WORKERS FAIL TO EARN PREMIUM

In the event a workman consistently fails to reach a standard which has been fairly and equitably set, it is well to realize that in all probability he is not fitted for the particular work he is doing. In all fairness to both employer and employee he should be transferred to other work, until he is fitted into his proper niche, which a little patience and fair dealing almost invariably find for him.

Cases will be encountered where an employee is naturally perverse, unreasonably stubborn, and simply will not try to attain a standard. Such a man is not thinking in the right direction, and harsh treatment and penalties make no impression upon him other than to increase his stubbornness and fan his antagonism to a greater heat. Often such a case can be cured by talking to the man quietly and sensibly, explaining and demonstrating matters simply and logically, appealing to the man's pride in his own personal welfare and that of his dependents, and showing him wherein he has an incorrect understanding of the entire situation.

Very few employees will fail to respond to such a course of treatment. When their thoughts are guided into the right channels, they ordinarily see their mistakes, although not always willing to admit them in so many words. They nevertheless show their appreciation and their new understanding of matters by conscientiously applying themselves, and sooner or later they actually reach and often surpass the standards for which they originally held such an antipathy.

Outside of the kind of employee just mentioned, employees ordinarily fail to earn premium either because of the standards improperly set, or the worker not adapted to the task, or possibly both.

In the first case it means a careful and thorough restudy of the operation or operations to determine wherein the existing standard is in error, and if it is in error their immediate correction, thereby insuring a fair and equitable standard in all respects.

In the second case it becomes a matter of endeavoring to place the worker on work to which he is better adapted and for which he has the greatest possible aptitude. This requires patience and the proper recognition of the human factor, for in many cases a worker who is a hopeless failure on one class of work is found to be an exceptionally efficient producer on another.

These characteristics have caused the plan to succeed and accomplish its purposes wherever installed.

The incentive held out to the workers makes possible a high rate of efficiency, maximum quality production per man, greatly increased costs, and increased profits.

A Development in Intra-Plant Communication

How the Printing Telegraph May Be Employed to Supplement the Telephone in Solving the Problem of Plant Communication

By DONALD McNICOL

Consulting Electrical Engineer

A PROGRAM aiming at the elimination of waste in plant operation presents many ordinarily unsuspected opportunities for reducing the number of necessary motions, and in many cases the degree of success attained is dependent upon the consideration given the related problem of intelligent transmission between directive centers and work stations. At the present moment there are in operation, or projected,

FIG. 1 A PRINTING TELEGRAPH IN USE IN THE ORDER DEPARTMENT OF THE GENERAL ELECTRIC COMPANIES' OFFICE AT CHICAGO

in various large industrial establishments improved methods of internal communication, and of all the various methods of attack against waste, having important possibilities in cost reduction, there is none perhaps which is viewed more favorably by workmen, or at least with less apprehensive questioning.

In the opening statement above the writer was prompted to use the words "unsuspected opportunities" in view of the fact that though there are now few large industrial establishments which have not abandoned the use of horses in favor of the auto truck and fewer still which could long survive without the use of the telegraph and telephone for outside communication, there are many which still depend for internal communication upon the occasional messenger boy or the picturesque tin speaking-tube.

The trouble is that the method or system of internal communication in a plant, large or small, is often the last thing to receive attention, and it happens frequently that when improvements do seem desirable all that is accomplished is "alteration" because the problem is turned over to the janitor or the house electrician.

Consider the case of the great corporations who sell communication—the telegraph companies and the telephone companies. The product they sell is quick communication over long as well as short distances, and the grade of this product is largely dependent upon the methods of internal communication used by them in performing the numerous functions that go with good service. One might suppose that a telephone company selling long-distance service would have no use for the dot-and-dash telegraph of Morse! On the contrary, the long-distance telephone lines in operation are closely associated with the quick and accurate telegraph. A telephone company makes use of telegraph methods whenever the telegraph is more economical or suits the particular purpose in hand better than does the telephone. Conversely, the telegraph companies know well just where they can employ telephone methods to better advantage than their own system.

For instance in a large telegraph center one may observe the following methods in use:

Messages to be passed between points a few feet apart:
By boy on foot.

Messages to be passed between points 100 feet or more apart:
By boys on roller skates, by pneumatic tube, or by constantly moving conveyor belts.

Messages to be passed between points a few city blocks apart:
Pneumatic tube, telephone, or telegraph.

Messages to be passed between points from two to twenty miles apart:
Telegraph or telephone.

Over longer distances:
Telegraph.

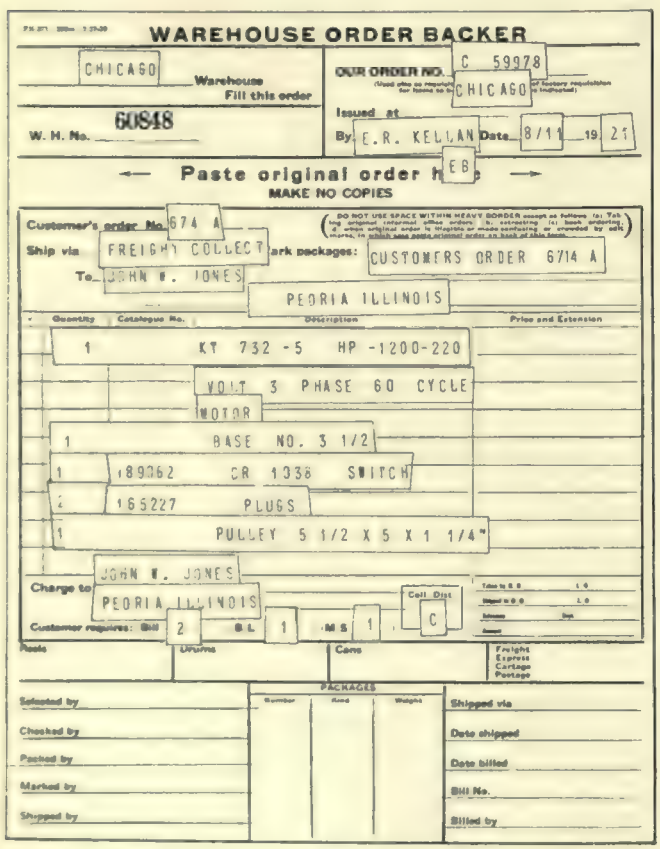
In many industrial plants messages must be passed between points approximating in distance those just mentioned, and the problem of maintaining communication is being met in a variety of ways.

Intercommunicating telephone systems, for example, which may be purchased outright and maintained by plant employees, have been applied to meet widely varying conditions. In such cases where the number of plant telephone stations exceeds 20 it is generally advisable to provide that the system be operated jointly with the commercial service branch exchange due to the fact that one or two switchboard operators can then attend to both internal and external calls, and that any of the plant telephone stations may be connected with

the outside commercial system. Moreover, whenever 50 or more plant telephone stations are required for internal communication alone the system should be centered in a manually or automatically operated switchboard.

Plants having 20 or less telephone stations may be equipped with simple intercommunicating telephone systems, not connected with the commercial telephone system and not requiring a central switchboard. Each telephone set is associated with a small, compact switching unit of the push-button type, so that any station may be called from any other station of the system. The cost of such systems is comparatively low and they are maintained at an almost negligible expense.

But while hundreds of manufacturing and other industrial plants now have inadequate internal communication where intercommunicating telephones could be installed both with great advantage to the organization and in the interests of waste elimination, on the other hand in the case of many plants which were equipped some years ago with intercommunicating telephone systems—at a time when the business of the companies was much smaller than it is today or is likely to


WAREHOUSE ORDER BACKER

CHICAGO — Warehouse Fill this order

OUR ORDER NO. C 59978

CHICAGO

W. H. No. 60848

Issued at

By E. R. KELLAN Date 8/11 19 21

← Paste original order here →

MAKE NO COPIES

Customer's order No. 674 A

Ship via FREIGHT COLLECT Mark packages: CUSTOMERS ORDER 6714 A

To JOHN W. JONES

PEORIA ILLINOIS

Quantity	Catalogue No.	Description	Price and Extension
1	KT 732 -5	HP -1200-220 VOLT 3 PHASE 60 CYCLE MOTOR	
1		BASE NO. 3 1/2	
1	189062	CR 1336 SWITCH	
4	165227	PLUGS	
1		PULLEY 5 1/2 X 5 X 1 1/4"	

Charge to JOHN W. JONES PEORIA ILLINOIS

Coll. Dist. C

Customer requires: Bill 2 B/L 1 M/S 1

Paste | Uprights | Cores | Freight Express Cartage Portage

PACKAGES

Selected by | Checked by | Packed by | Marked by | Shipped by

Number | Kind | Weight

Shipped via | Date shipped | Date billed | Bill No. | Billed by

FIG. 2 A WAREHOUSE ORDER TRANSMITTED BY THE PRINTING TELEGRAPH

This order is made out by pasting upon a standard form the printed tape as it comes from the receiving typewriter. A foot of the tape contains about 15 words.

be in the near future—extensions or improvements better adapted to present-day conditions could now be undertaken with considerable profit.

A large wholesale dry-goods company in Chicago has its warehouse and stockrooms about three miles from the executive offices. Recently the company inaugurated a campaign for increased business through the medium of mail orders. A thoroughly organized shipping service for this business made it possible invariably to ship on the same day the order was received. The business grew so rapidly that soon the means of communication between the company's offices and the warehouse became clogged up. Errors became numerous and it was

FIG. 3 A PRINTING TELEGRAPH TRANSMITTER

This machine is operated the same as a typewriter, and the transmitted message is reproduced in the form of a printed tape as shown in Fig. 2.

costing a considerable sum of money to correct these errors and to handle complaints.

On investigation it was found that the errors occurred while orders were being telephoned to the warehouse, and though additional lines and additional operators brought about a reduction in the errors, there were still too many complaints. Moreover, the charges for additional lines and the salaries for operators reached a point where the cost of the service was too high. Finally it was decided to instal the printing telegraph, and when this was done complaints practically ceased, thus permitting the mail order business to increase without the handicap of poor service.

The fact that mercantile and merchandising concerns have been the first to recognize the economies and advantages of improving their internal communication methods may be accounted for by the fact that these companies were probably the first to encounter the new trade conditions following the close of the Great War. The discouraging problems attendant upon sudden changes in quoted prices of raw products and of manufactured articles could best be met by steadying sales to the ultimate consumer. Many companies found that advertising campaigns created increased demand for goods; but competing companies were quick to start such campaigns also, and this meant that the house which rendered the most prompt and unfailing service forged ahead in gross sales. Prompt handling of orders,

prompt shipment, and follow-up delivery are impossible, however, unless the system of internal communication between departments functions instantaneously and without errors.

The conditions of trade which confronted mercantile establishments when reconstruction set in are now clouding the atmosphere of both large and small industrial and engineering concerns. Costs analyses and production statistics, if complete and thorough, cannot leave out the problem of internal communication between work points which are close together or far apart. Among the large engineering companies first to sense the advantages of the printing telegraph system in handling certain classes of internal traffic is the General Electric Company, which employs a printing telegraph system in transmitting information regarding orders between the sales offices and warehouses. In one case the distance covered is three and one-half miles. It might seem that telephone service would here answer the requirements; after a thorough engineering study of the requirements and of the available methods of meeting those requirements, the General Electric Company decided that a printing telegraph system was the best for the purpose.

The Western Electric Company, at the great Hawthorne shops in Illinois, is also engaged in making a study of the possibilities of new methods of internal communication between a large number of shop and work centers and other industries might well profit from similar studies.

Briefly stated the outstanding advantages of a printing telegraph system for communication purposes are:

1. At the transmitter a record is automatically made of the transmitted message—a duplicate of that recorded at the distance receiver.
2. The transmitter keyboard may be operated by any person by merely depressing the keys. Typists can transmit rapidly.
3. The receiving instrument takes care of the incoming messages without requiring the presence of an attendant.
4. Where several lines are necessary for heavy traffic one attendant can serve two or more printers.
5. When a boy is employed to deliver all received messages, the person for whom the message is intended does not have to leave his work.
6. A third machine may be installed, as in the credit department, where an automatic printed record will be made of all orders passing from the executive offices to the stockroom.
7. The machines sending and receiving may be purchased outright for about $750 complete.

Such reliable, accurate, and economical methods of internal communication make possible the segregation of department activities so as to take advantage of renting conditions. There are organizations where concentration of staff and departments under one roof is advantageous, but where building congestion forces rentals to high figures, and undoubtedly there are many companies with headquarters in metropolitan districts which could effect savings by maintaining smaller floor area in congested districts. Numerous operations now performed in the heart of the business district of a city might just as well be performed five or ten miles away where rental conditions are more favorable and where transportation facilities for employees are less crowded, less unhealthy.

Finally, present-day methods of internal communication may be applied in various ways to effect economies in plant or company management and managers and engineers charged with the problem of eliminating waste have in the matter of communication a facility which is only too often handed over to non-engineering attention, but which has easily determined advantages in bringing about improvement in service to the public and important possibilities in plant costs reduction.

Management engineering. Supervision *658.372*

Supervision That Supervises

By E. G. FREMONT

With the Emerson Engineers

OF the many factors of management that enter into the making of a successful plant, one of the most important is supervision; and because it is so important one would expect it invariably to receive enough thought and attention to make it efficient. So far is this from being the case, that many supervising heads not only do not supervise in the real sense of the word, but often have a total misconception of the actual duties of supervision.

In the period just ahead of us it will be more and more necessary to have supervision that supervises. From now on, if American industry is to compete successfully with European manufacturers, it will be essential for the supervisor to know definitely what can be produced from a given operation, or machine, to make sure that the quality of product is of the highest standard, and to see that rejections are kept at the lowest possible point, in order that costs can be maintained within reasonable limits.

Three Elements in Production

Quality, service, and low costs are the three fundamentals that American industry must strive for in order to get a proper share of the world's business, and all of these are primarily the concern of the supervising heads. There can be no dodging the issue—if quality, service, and costs are not improved it will be a direct reflection upon the ability of those who supervise, and supervisors, like other men, should be judged by what they do, not by what they say.

It is always easy to give excuses and to find reasons for not getting work done, but if the same diligence were applied to finding out why work is not done as is often spent in digging up excuses, the chances are that the work would come through on time; at least it would come through on time in future cases. When a superintendent busies himself repairing machinery, making out reports, chasing orders, and the like, he is

not doing the proper work of supervision. He is simply doing what an ordinary mechanic or clerk can do just as well as he and probably better.

The real supervisor is the one who goes out in the shop and gives help and encouragement to the men under him; he assists them to overcome their difficulties, and at the same time he finds out whether each one is producing his required standard of work, whether each one is maintaining quality; and whenever rejections are high, he analyzes the causes and makes plans for their elimination. Such a supervisor is constantly in touch with his work, he knows definitely what is going on, and his men know that he knows, and it is knowledge of this kind on the part of the men which makes every worker strive to do his best. Workmen realize that they cannot deceive a man of this caliber, that they cannot give excuses or pass responsibility for mistakes on to others, and that what they and they alone do will be the sole reason for their advancement. In other words, they know that they must produce results or make way for those who can.

SUPERVISION IS BASED ON KNOWLEDGE

No man can properly supervise work unless he has certain essential knowledge; yet many men call themselves executives—superintendents and foremen—who do not know what constitutes a fair day's work; who do not know how much idle equipment exists in their department; who do not know from one day to the next the condition of work in their department; who do not know whether they are producing the work as economically as they should. Such men usually try to get work done that will just pass. They never try for perfection, and therefore rejections in the department of which such men happen to be the head are likely to be high rather than low.

One great advantage enjoyed by the supervisor who is in touch with all phases of his work and thoroughly knows conditions lies in the fact that he is in a position to make important decisions quickly. Moreover, his decisions will be based upon facts and, therefore, will be made not only quickly but accurately. Just think of the time that this one practice alone would save in many establishments! Everyone is familiar with cases where important work has been held up because of the difficulty of getting a decision from the directing executive, and the usual reason for delay is because the executive is not in close enough touch with the work to know the detailed facts and has to take time to look them up while the work waits. The value of a man who can make decisions quickly and whose decisions are "usually accurate"—for it is not possible for any human being to make every decision accurate—is beyond question.

SUPERVISION BRINGS CONFIDENCE

In addition to the ability to make quick decisions, the man in close touch with his work gains from such knowledge confidence in himself to produce results. Confidence in one's self usually begets the confidence of others, and to obtain and retain the confidence of the men working under him is vitally important for any executive. Where the executive has the confidence of his fellow workers, harmony and co-operation are usually to be found, as most men like to work for a leader whom they can look up to. On the other hand men have no respect for the man who does not know his job, who lacks decision and generally is not sure of himself. Such a man is considered a weakling and consequently has no control over his subordinates.

As an example of a poor executive the writer has in mind a superintendent who supervises from his office. He busies himself signing time clock cards, requisitions, etc., interviewing prospective employees, chasing up material and poring over orders, all of which a clerk could do just as well. If a foreman wants to see him he has to come to the office and often is obliged to wait for half-an-hour or so, in the meantime leaving his department to its own resources. Foremen going to this superintendent's office have at times taken on the appearance of being in a procession, and the writer has seen as many as five foremen waiting at one time for a chance to discuss matters with him.

SUPERVISOR EXECUTES PLANS

In contrast, in well-run establishments, foremen never leave their departments except under unusual conditions. They remain on the job, and far from waiting to be called when something goes wrong they are continually going over the work to prevent such a contingency. In an establishment so conducted the superintendent spends the greater part of the day in the factory, going from one department to another and taking up with each foreman questions that affect his particular department. In this way, if any question about the work comes up, the work and the conditions under which it is performed can be observed at first-hand.

On these visits the superintendent can note whether the department is using all equipment to advantage, whether the work going through is being done efficiently, and whether or not it is up to the required standard of workmanship. All rejected work should be gone over with the foreman, the reasons for such rejections determined upon, and plans made to overcome the causes of defects. And here is where the real work of supervision comes in—to see that plans are faithfully executed, for plans are not worth the paper they are written on until they are put into practice.

Finally, the superintendent should not be content to visit his departments but once each day, but should make as many trips through the factory as possible, for conditions in the shops are constantly changing, and no matter how many times he goes through a department there will always be some matter that will need his attention. In addition, he can profitably spend some time getting acquainted with the employees, listening to their personal complaints and suggestions, and usually such men if given proper encouragement are glad to tell the management what they know about the work and to make suggestions for improving it.

The 100 Per Cent Factory Foreman

By GIFFORD K. SIMONDS

General Manager, Simonds Saw Manufacturing Company

IN these days of reaction following the war, men are being sifted more carefully than ever, and it never was more important to be sure that those occupying key positions like the foremen should be of the right material. Furthermore, industry can afford to educate and develop the right kind of foremen better than it can afford to do almost anything else and many of the larger manufacturing plants are today picking out from all the foremen those who give promise of being worth further training and education.

That the factory foreman holds the key position to success or failure in manufacturing is almost universally agreed, and, therefore, today many companies are selecting him with care and spending much time and large amounts of money on his proper training. Indeed a number of organizations have sprung up whose sole business it is to give foremen training wherever desired, for a price.

What Qualities Make the Best Foremen?

As showing the various qualities a good foreman should have, the following experiment of the company with which the writer is connected should be of interest. Some of his qualities, of course, as with everyone else, come by birth and others by education and experience. Realizing that the first step in intelligent foreman training is a study of the foremen themselves and of their particular needs, we sent out in January, 1921, the following letter to every foreman in our employ:

The 100 Per Cent Factory Foreman

I am making a study of the 100 per cent factory foreman. Of course you and I know that there isn't any such creature, but what would he be like if one should happen to be discovered? He would know thoroughly the work that his men were doing. But what would be his relations with the superintendent over him and with the men under him? What qualities would best secure the greatest production with the best feeling?

If you will let me know soon from your experience briefly what qualities you think do make the best foreman, it will help me in getting together this little study and will, I hope, be of considerable help to all the other foremen employed by us.

The foremen who were questioned probably rank in intelligence and ability with the average foreman. Many of them have been with the company for a long period of years and practically all of them have had the benefit of at least a common school education, so that it was not surprising to find that not a few of them were well able to analyze and many of them evidently had considerable faith in theory.

Present-day psychologists affirm that the power of analysis is not a *general* power but a *special* one; that is, while a doctor might give a splendid analysis of a complicated case he was treating, yet he might fail absolutely to analyze a business problem; and while an artist might analyze a painting and point out its merits in composition and its faults in drawing and color, the business man usually would be absolutely unable to make any analysis at all. Most foremen consciously or unconsciously analyze the jobs which they direct, and with very little guidance and instruction those who do not have the power to analyze their jobs consciously can readily acquire it. As for theory, nearly every foreman has his own, and usually about wages and profits, open and closed shop, promotion, and the like.

Foremen Have Faith in Training Courses

Foremen also have faith in training courses, if the fundamental principles of teachings are observed in the planning and conducting of these courses—that is, such courses must be closely adapted in their content to the men and conducted in a way to really instruct them in matters that they believe will be of value.

Certainly foremen like to show up a college man, that is, when the man is nothing but a college man and when the emphasis is upon *college* instead of upon *man*, but for that matter so does everyone else. A practical man who has been successful in business said to me the other day, "A college man is good for nothing in business the first two years. It takes two years for him to forget that he has been to college, but after that there is a good chance that he will develop faster because he has been to college."

Foremen enjoy talking shop, and the fact that they do shows their interest in their jobs, and that they are jealous of authority proves that they are willing to take responsibility and with it credit or blame.

Two of their strongest points are that they think best when driven to the wall and that they will gladly co-operate with those in whom they have confidence. Even a baby will not co-operate well, if at all, with a person in whom he does not have confidence.

Qualifications Mentioned in the Letters

Fifty-six foremen answered the letter, and the qualifications most commonly mentioned by them were as follows:

Secure the greatest production	29
Thoroughly understand all parts of the work in his department	26
Treat the men fairly	25
Have the good-will of his men	17
Be friendly yet dignified with the men	16
Be loyal to the company	14
Listen to suggestions from the men	13
Have the ability to instruct the men	11
Understand human nature	11

Honesty toward the men and the company	11
Always be on time	10
Should study the men	10
Accept suggestions from the superintendent	8
Be tactful	8
Have the confidence and co-operation of the superintendent	7

One hundred and thirty-seven other desirable characteristics were also given, but of them all those quoted below seem to the writer the most important. The first one, if really lived up to by every foreman, would include all the rest. Any man who works on his job as he would for himself, if the man is good for anything, is doing all his employer can expect. If he is not good for anything he is doing all that anybody can expect; and if he is not doing enough, he should be invited to find another field of labor.

He must work for the company as he would for himself, try to promote a better understanding between the men and their employer and make them proud of the house that employs them. He should believe that those in authority over him appreciate his ability and are glad to see him grow, and he must be able to co-operate and to fit himself in a helpful way into the general scheme of things.

He should own property, be connected with some church, have a good character, and some standing in his community.

He needs to have a larger vision than his men, not only of his job, but of life; should never lose his temper; never criticise his superiors to his men; and he must never try to make good at some other man's expense. He should be willing to make decisions and should always keep his mental balance and poise. He must be "a good all round sport" with a personality of his own, and never be content to stand still but should be constantly growing. He should also be a good mixer, and not a "grand-stand" player.

He should keep posted on his work and related work by reading good magazines and books. He should always be guided by the Golden Rule, and when he has made a decision he should stand by it, unless he finds without question that he is wrong.

He should set an example for his men in all things; should not consider himself better than they are, even though he may know more about the department; and must be able to do as much or more than he expects any one of them to do. He should lead his men and not drive them, but be a good fighter; make no promises to them which cannot be kept; and never try to borrow money from them.

One of his chief characteristics should be to get teamwork from his men. He should see their faults and try to remedy them, being watchful of the quantity and quality of production. He should give a man credit when it is due him and a word of praise whenever possible, in order to make him feel that he amounts to something and that he has some responsibility. He should also try to get his men to save money.

He should deal with his men as persons and not as things, and be willing to share the blame as well as the praise with them. He should represent and defend them whenever they are right, and never reprimand one man before another or criticise one of his men to another. He should also discourage the men coming to him with trifles, and it should be his duty to maintain cleanliness in his department and always watch for safety.

QUALIFICATIONS OF THE 100 PER CENT FOREMAN

Many of the replies expressed the ideal qualifications in one or two words. Summing them all up, these would describe the 100 per cent foreman:

The foreman should be enthusiastic, discreet, sympathetic, human, self-confident, sound-minded, sober, energetic, cautious, considerate, moderate, unselfish, cheerful and happy, possess self-control, be a leader, show initiative, be conscientious, healthy, sincere, persevering, and have a good memory and common sense.

In his relations with his men he should be just, patient, diplomatic, square, tactful, and firm.

In connection with the company for which he works he should be progressive, dependable, intelligent, resourceful, trustful, faithful, industrious, and saving.

This experiment and these letters prove that foremen think about their work, that they realize they deal with human beings as well as machines and that both need constant care and watchfulness. They show also that after all the human element is a greater factor in making business profitable than is the machine.

Time study. Management *658.543*

A Bold Evaluation of Time Study

By FRANCIS GOODELL

With the Leffingwell-Ream Company

If there were some process by which all desires except the desire for fairness could be taken from men engaged in or connected with industry, our troubles would cease.[1]

DO you remember Wells's "In the Days of the Comet"? The contact of the comet added a purifying ingredient to the air. This ingredient rationalized mankind; it brought strife to an end; it liberated love. It is my conviction that the practice of time study is slowly having the same effect.

The statement is a bold one. In none of the articles in defense of time study have I seen it made. The Congressional discussions did not bring out this striking claim. The textbooks on time study do not encourage and guide time students with any such stimulating motive. This omission of all mention of the enormous social value of time study should, I believe, be supplied.

I shall not go over the charges so often brought against time study. Many abuses have arisen, perhaps equal to the storm of criticism of its practice. Yet the very capacity for abuse is a proof of the potential value of time study. At all events, replies to criticism have already been published many times.

It must also be made clear that this is not a defense of piecework. Piecework can never be very successful unless preceded by time study. But time study may be extremely useful without any form of piecework. Piecework, like feudalism, is a useful device in a certain stage of development. Time study, on the contrary, is useful in all stages like any other search for truth.

THE PURPOSE OF TIME STUDY

The purpose of time study is to determine the right time for doing a job. I shall speak of "the right time" as if it were a simple thing, easily found and unvarying. Yet there are many irregularities to be eliminated. many men to be studied, and many "elemental times" to be found. These elemental times must be put together in almost innumerable combinations for the vari-

[1] Samuel Gompers.

ous processes and jobs. But the technique of time study has been fully described, and the expression "the right time" will be used for the sake of brevity and clarity.

Moreover, the right time as so determined is not absolutely accurate. But it is more nearly accurate than any other known method. And as it is made up of elements, each one of which is readily found, the sum of the elements, or the right time, is easily proved. It may, therefore, be said that time study does supply the right time in a perfectly satisfactory way.

Where the right time is not known, there is continual skirmishing on the subject. The foremen almost always maintain that the work can be done in less time than the men consume; and the men carefully, hour by hour and with seldom a slip, work at such a rate as not to betray the possibility of greater output. In a certain small loft where "pants" were made, every one of 15 operators kept a record of his work as a defense against possible attack by the foreman, and yet it was a closed shop, in agreement with the Amalgamated Clothing Workers, and the foreman was not supposed to include discipline among his duties. He simply could not help himself. And in that shop, as in every other with which I have the slightest acquaintance, the lack of knowledge as to the right time brings either open or hidden warfare on the subject of output.

FAILURE TO KNOW "RIGHT TIME" LOWERS OUTPUT

The psychology of the workman is about as follows: The average worker (excluding those who are lazy or who have a grievance) restrains his output because of the pressure of his fellows. Either he is afraid of them, or more often he has too keen a sense of loyalty to work at a rate which will become a "pace" for the others. Yet he must, if possible, insure the safety of his job. He wants the foreman to realize that he is an able workman, too good to lose, and perhaps a fit candidate for promotion. He may also have a certain respect or regard for the foreman. So he tends to play up to the foreman, to make him think that he (the workman) has the best interests of the firm at heart, that he puts in extraordinary effort to make the product more nearly perfect than do some of the others. I am not criticising this attitude; it is a natural tendency. Were you or I in the worker's position we might easily adopt the same tactics. The evil of such an attitude is that a premium is put upon becoming a first-class humbug. It is a bad system that bribes one into waste and laziness. It is even worse that the workman, in order to protect his job and his future, must fawn on the man over him.

Just as soon, however, as the workman is convinced that time study has given the right time for his job there is no longer any advantage in this steady soldiering. Though time study may not stimulate the workman to his best endeavor, it at least makes him feel that he no longer damages his colleagues by doing his best work. He can measure himself against the standard, if he wishes, without creating a new record to which all the workmen will be held. He can maintain his self-respect by proving his ability. And he must rely on achievement to "make good." No longer will pretensions pass for prowess. His opportunity lies in doing well the job he has chosen for his specialty, with the confidence that his honest effort can now be recognized. He has the expert's opportunity with more than the expert's chance to prove his value.

HOW TIME STUDY AFFECTS THE WORKMAN

It is hard to overestimate the contrast between the atmosphere in the ordinary shop and one in which the facts of the processes are known. In the one are found slyness and distrust of one's mates, in the other openness and trust; in the one toadying and obsequiousness are practiced by the workmen, and bluff, bullying, and worse by the foremen; in the other shop a manly attitude is the rule, together with honesty, industry, and genuine friendship where it naturally arises.

The attitude of the workman in the shop affects his attitude in the home. The continual practice of honesty or deceit, of trust or distrust during the day, makes or unmakes the father and the citizen. The continual practice of high ideals during working hours goes into the bones and the very marrow of the bones. Gradually the workman comes to abhor the grafter and to feel that the one who does not earn his way is less than a man. The great American ideal "to slip one over" loses its appeal. And all this extends much farther than the individuals directly concerned, since no attribute is more important to the state than the desire on the part of its citizens to give as well as to receive justice.

Upon the management—and by management I mean the agencies that develop the policies of a company and carry them out—the effect of time study is even more important, for while the effect of time study upon the management is somewhat similar to that produced upon the workmen, the problems of management being more numerous and complex, and in fact comprising all those of labor, have a greater influence upon society at large.

A NEW PROBLEM FOR MANAGEMENT

When time study is begun, management approaches a new sort of problem on a measurement basis. It begins to isolate and attack problems in a purposeful way. Many decisions that have previously been left to chance, many prerogatives that have been assumed as rights, now become the subject of pointed attention. As an illustration of this the question of quality must not infrequently be settled by supplying standards. Early in the war such a need arose in a certain loft where among other things hammock clews were being made for the navy. The men had been put upon piecework without any sort of preliminary time study (time study is still prohibited in government work) and the men were making demoralizing wages and also demoralizing hammock clews. To my suggestion of a standard sample the foreman raised strenuous objections. "If I set a standard for 'em, I'll set the best blankety blankety clew I can make." "Then," said I, "they won't be able to come up to standard." "Well, let 'em do their damnedest." The foreman wanted to preserve

the prerogative of "bawling them out" whenever he felt like it; whereas the clew makers had a perfect right to definite information as to what would pass.

THE NEED FOR MEASUREMENT IN MANAGEMENT

The need of measurement or standardization is by no means restricted to the finished product, it arises all through the process, and the management is obliged to meet this need before it can establish predictable times for the jobs. These simple physical problems give the first lessons in the engineering attitude, and gradually it becomes clear that many issues of constant annoyance can be settled indisputably by measurement and test. Tests of raw materials have saved many a workman his job, and not infrequently have lighted the torch of scientific test in the plant which furnished them.

Beginning with these simple examples, the attitude begins to have effect upon less tangible problems. Sometimes months, sometimes years, are needed for this spirit to ripen. But once planted, I have never known it to be killed, though occasionally the "system" which started it is ejected as an apparent failure. One reason why the attitude is hardy is the number of difficult questions which demand answers. Every year it becomes more important to demonstrate that a certain stand is just, and by accumulating facts bearing on the subject and arranging them in an organized way solutions of problems become more nearly just. What is more important, matters can be explained step by step, corrected if necessary, and the solution accepted on the basis of reason.

Perhaps the most timely example of this method of approach is in controlling the size of the labor force. The amount of work ahead, called the "balance of work," is being widely used to regulate the force on the pay-roll. When this balance is closely watched, it is possible to foresee the necessary changes and make them with the minimum of hardship to the employees. And in addition, when the facts which concern the problem are arranged in this way and laid before the workmen, they are quick to recognize the need of action and are intelligent and disinterested in their co-operation.

THE VALUE OF ENGINEERING METHODS

By means of the practice of the engineering approach management slowly acquires the habit of desiring only its rights. There are all sorts of managers and employers and no one typical change will describe the action of the engineering approach upon them. I do not think that many suddenly see a bright celestial light and resolve to reform. When their practices are low, it is often due either to a belligerent attitude toward their help and toward labor in general, or, perhaps more often, to the assumption of rights which they have never heard authoritatively questioned. Both of these hindrances to continued successful management are gradually undermined by approaching problems in the light of organized facts. Then, and usually not until then, do such men realize that management is a fine art in the practice of which there is scope not only for all of their skill, but also for all their finer feelings.

To show that others are watching this tendency a paragraph is quoted from Mr. Gompers in the June American Federationist:

> The labor movement is hopeful today because there are abundant signs that the engineers and the scientists have recovered from and progressed *far beyond* that pseudo-science that brought them such ill-repute a decade ago when "speed up" was their watch-word and when humanity was classed with steel and wood as material for the production of goods.[1]

The movement which is in progress is the elimination of privilege from industry. This is not a utopian impossibility. In the field of politics flagrant forms of privilege have long since been swept away; and in an increasing number of plants where the engineering attitude has been thoroughly learned, labor troubles have ceased and prosperity has rewarded both labor and management.

Thus through time study comes the opportunity: first, for a relatively simple example of the engineering approach, getting all concerned away from the old demoralizing wrangles based on bluff and prejudice; and second, for the stimulus to use this approach in wider and wider fields. Both labor and management learn by continual practice the fundamental lesson that they must earn what they get. As by Wells's comet, their relationship is rationalized, strife is brought to an end, and love is liberated—love of one's fellow man, love of the arts of labor and of management.

A workman's conservation committee which assists the management in factory housekeeping is a feature of the organization of the Crocker-McElwain Paper plant. This committee inaugurated its activities by a campaign for cleanliness and conservation which proved to be so valuable that its results were made permanent by a series of weekly inspections. The condition of each department is analyzed, the department is then rated and the score is posted in every department. The value of the rating for cleanliness and waste reduction is evident from the questions themselves, which follow, each question being rated on a basis of 10:

1. Are floors and corners well swept and in as good condition as the sort of work will permit?
2. Are window-sills clean?
3. Are there any window panes broken?
4. Are lockers and clothes racks neat and in proper condition?
5. Are truck handles properly turned back out of the aisles?
6. Are the piles of paper, cases, box-boards or other materials properly lined up?
7. Are there any unnecessary lights left burning?
8. Are there any steam valves or broken pipes leaking?
9. Is all machinery and equipment clean and well cared for?
10. Are all fire doors, water-barrels, etc., ready for instant use?

[1] The italics are mine.

THE LABOR SUMMARY

Statistics and News from Industry

Employment, Industrial *331.1*

Employment Increased During August

EMPLOYMENT in American industries, after declining continuously since January, 1921, turned during the month of August and now shows an upward trend. This fact is revealed by figures collected by the U. S. Employment Service from 1,428 firms who normally employ 500 or more workers. Details show that whereas during July there were 1,520,210 workers on the payrolls in August there were 1,526,479, an increase of 16,269, or approximately 1.08 per cent. Employment still shows, however, a loss of 101,655 workers since the first of the year, or about 6.2 per cent.

The figures compiled by the Employment Service are given in somewhat condensed form in Table 1, a brief inspection of which reveals the fact that of the 14 industrial groups reporting 8 shows an increase in employment and 6 a decrease, the most marked improvement being witnessed in the food products group, which reported a gain of 9,450 workers over the previous month. The iron and steel industry also gained in employment, with an increase of 6,726 workers, while third on the list comes metal and metal products, other than iron and steel, with an increase of 3,877. But two of the groups show large decreases, the miscellaneous industries losing 6,604 workers and the manufacture of vehicles for land transportation 5,520.

TABLE I. THE TREND OF EMPLOYMENT IN 1428 AMERICAN INDUSTRIES DURING AUGUST, 1921

(Compiled by the U. S. Employment Service, U. S. Dept. of Labor)

Industrial Group	Number on Pay-Roll		Net Change July to August	Net Change Since Jan., 1921
	July 31	August 31		
1. Food and kindred products	123,871	133,321	+9,450	—4,123
2. Textiles and their products	260,460	263,257	+2,797	+39,552
3. Iron and steel and their products	300,441	307,167	+6,726	—136,587
4. Lumber and its manufacture	22,736	22,097	—639	—1,921
5. Leather and its finished products	52,781	55,117	+2,336	+15,732
6. Paper and printing	49,878	49,177	—701	—3,688
7. Liquor and beverages	1,551	1,421	—130	—326
8. Chemicals and allied products	70,503	69,859	—644	—14,944
9. Stone, clay, and glass products	11,110	11,770	+660	—3,332
10. Metal and metal products other than steel and iron	71,663	75,540	+3,877	—4,124
11. Tobacco manufacturers	30,666	31,904	+1,238	+3,625
12. Vehicles for land transportation	180,148	174,628	—5,520	+80,776
13. Railroad repair shops	60,225	63,648	+3,423	+530
14. Miscellaneous industries	274,177	267,523	—6,604	—72,825
Total	1,510,210	1,526,479	+16,269	—101,655

At first glance such figures might seem to indicate that the low point of industrial depression has at last been reached and past. A careful study of the data will show, however, that the improvements can be traced in very large measure to the agricultural activities of the month, and that as yet the major manufacturing, mining, and transportation industries have shown but small gains, although there are indications of improvement in the iron and steel group and a marked re-employment in railroad occupations.

The figure of the Employment Service, when studied on the basis of geographical distribution, show that of the 65 cities reporting 38 showed a gain of 41,455 workers while 27 reported a decrease of 25,186, or a net gain of 16,269. A list of these 65 cities together with the amount of decrease or increase in each during August is given on the second page following. A brief summary of employment conditions throughout the various sections of the country follows immediately.

New England District (Me., N. H., Vt., Mass., R. I., and Conn.). Serious unemployment continues in the metal trades, textiles, shoes, building trades, and transportation circles. Metals and metal products are at a very low ebb, with nothing encouraging in sight. Shoes and leather are on a basis of about 70 per cent. Lumber and its products are very quiet. Retail sales are reported as having fallen off. On the other hand, textiles have shown a decided improvement, with bright prospects for woolens during the entire winter. An increase in building operations is indicated by reports which show that contracts awarded during July aggregate $20,823,000 as against $16,210,000 for June.

Middle Atlantic Division (N. Y., N. J., and Pa.). Reports from 30 cities in this district indicate a more general feeling of optimism than has prevailed for several months. Here and there signs of improvement in the steel industry are evident. Building construction is fairly under way in all parts of the district. Railroads are re-employing men laid off several months ago and are beginning to repair equipment. Textiles, shoes, and clothing are fairly active, and future prospects are encouraging.

East North Central District (Ohio, Ill., Ind., Mich., and Wis.). In Ohio railroad repairs have displayed increased activity, stimulating business in foundries and other lines, while there have been increased inquiries for steel quotations. Plans and specifications for structural work which have been laid away, are now coming to light for figures and estimates. In Illinois while business continues at a standstill, the outlook for the future is brighter. The reopening of mines for the fall trade will help business in the southern part of the state. Many factories have been operating at one-third capacity. There is slight improvement in iron and steel. Indiana seems to be holding her own

pretty steadily, and though indications do not warrant the feeling that conditions will be very bright for the balance of the year, general sentiment appears more optimistic and encouraging. Retail buying is still very conservative, and in many sections sales have been falling off since July. A survey of Michigan, taking into consideration mining, lumber, furniture, stoves, automobiles, paper, and drugs, indicates operations' estimates at about 60 per cent of normal. Throughout Wisconsin automobiles and rubber tires show increased activity, while agricultural implements are dull. The largest road construction project ever undertaken by the state, involving the building of 2,400 miles of concrete and gravel highways, is now under way.

West North Central District (Minn., Iowa, Mo., N. D., S. D., Neb., and Kan.). Better business conditions are directly traceable to the harvest and the movement of crops. Flour mills are operating at practically full capacity, railroad repair shops continue to increase their forces, packing plans are busy, and retail sales have improved. The work-clothing industry has shown marked improvement, and boots and shoes have been increasingly busy since early spring. On the other hand, the implement and equipment lines are considerably curtailed. Adjustment of controversies in the building trades has come so late in the season that lowered costs of construction have failed to stimulate building. In some of the larger cities the surplus of unskilled labor is growing rapidly, due in part to the return of harvesters, many of whom are ex-service men.

South Atlantic District (Del., Md., D. C., Va., W. Va., N. C., S. C., Ga., and Fla.). Very gratifying increases have taken place in railroad occupations and textiles throughout the district. Textile operators generally express satisfaction with the outlook for future business; also 103 lumber products plants, employing 8191 in Georgia, North Carolina, South Carolina, and Florida show a small increase, though operators seem to think the outlook is not encouraging. Twenty-two coal mine operators in Virginia, employing 6349, show a decrease of 126. Operators generally are discouraged as to the outlook, while some express confidence that conditions will improve in the near future. Unemployment continues in iron and steel, and among unskilled labor, the outlook for the latter class being extremely discouraging. Building is active in spots.

East South Central District (Ky., Tenn., Ala., and Miss.). Lumber has shown slight improvement, due to heavier demand. Several yellow pine mills of Alabama and Mississippi have recently resumed, after being closed for months, and their production for the current month is about 80 per cent of normal. Hardwood production is still less than 50 per cent of normal, the dulness being most pronounced in Mississippi, where restricted operations have reduced the output two-thirds. Actual production of both hardwoods and pine is well under current demands, and reserve stocks in manufacturers' hands are beginning to show signs of exhaustion—circumstances that necessitate a heavier output and assure a steady increase in employment, at least until cold weather. There has been no improvement in coal mining. In Tennessee and Southeastern Kentucky, during July, out of a total of 300 mines, each employing from 25 to 100, 132 were not operating. This is more than a third of the total in the district and represents large normal production. Such mines as are operating are not running more than two or three days per week, except those loading fuel coal for the railroads. The demand is far short of normal. In Western Kentucky many mines are still idle; those that are working are operating only two days per week. In Alabama there are partly employed approximately 80 per cent of the number reported at the beginning of the year. Iron and steel have been quiet, though preparations are being made for a gradual resumption. Many factories are on a part-time basis.

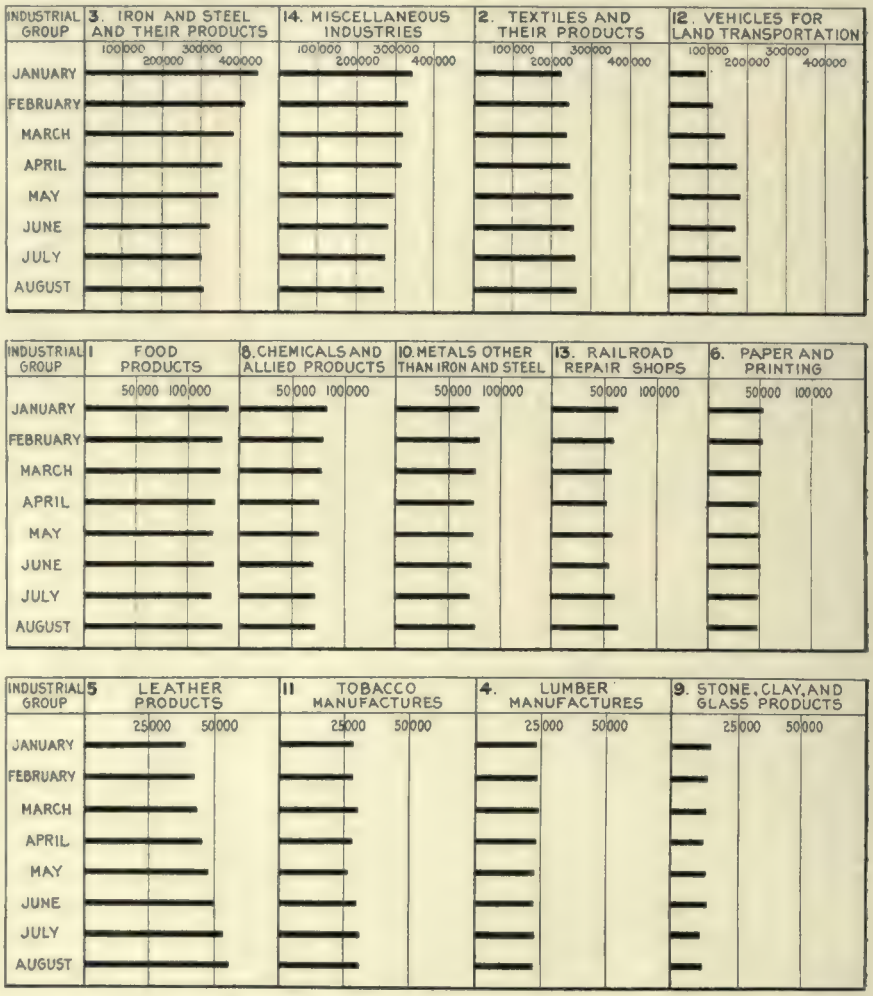


FIG. 1 THE TREND OF INDUSTRIAL EMPLOYMENT SINCE JANUARY, 1921

West South Central District (Ark., La., Okla., and Texas). The industrial situation throughout this district is unimproved and large unemployment and part-time continue in oil, lumber, cotton seed products, machinery and metals, and packing houses. The number of unemployed will be increased by return of men from harvest fields. Railroads have increased shop and operating forces and building trades are more active in some sections. Housing situation has shown market improvement in many cities. Merchandising is steady.

Mountain District (Mont., Idaho, Wyo., Colo., N. M., Utah, Ariz., and Nev.). Manufacturing shows but slight improvement, although an upward trend is looked for during the next 60 or 90 days. Railroad activities have somewhat increased due to excellent crop conditions through the district. Mining in general continues much restricted, with the exception of coal mining, which is beginning to pick up. Building is on the increase. Public improvements, which have been affording considerable improvement, are slackening. Increased optimism in regard to general conditions is expressed.

Pacific Division (Wash., Ore., and Cal.). Industry in general continues below normal, though unemployment has been slightly relieved by increased seasonal activities. Lumber is operating 65 per cent of normal, with many mills and logging camps closed. Some food preserving plants are operating on

a restricted basis, due to market conditions. Increased building activities are observable in some cities. Farm labor demand is everywhere below seasonal average.

CITIES REPORTING AN INCREASE IN EMPLOYMENT IN AUGUST, 1921		CITIES REPORTING A DECREASE IN EMPLOYMENT IN AUGUST, 1921	
Youngstown, Ohio	4,617	Toledo, Ohio	3,149
Grand Rapids, Mich.	811	Lawrence, Mass.	3,388
Peoria, Ill.	363	Bayonne, N. J.	1,117
Seattle, Wash.	329	Camden, N. J.	2,494
Denver, Col.	249	Baltimore, Md.	2,444
Cleveland, Ohio.	6,546	Atlanta, Ga.	660
Yonkers, N. Y.	903	San Francisco, Cal.	534
Chicago, Ill.	11,846	Jersey City, N. J.	952
Kansas City, Kan.	827	Sioux City, Ia.	185
Johnstown, Pa.	651	Kansas City, Mo.	355
New Haven, Conn.	647	Pittsburgh, Pa.	2,769
Chattanooga, Tenn.	314	Niagara Falls, N. Y.	163
Birmingham, Ala.	1,062	Cincinnati, Ohio.	502
Memphis, Tenn.	147	Worcester, Mass.	641
Manchester, N. H.	1,120	Indianapolis, Ind.	437
Buffalo, N. Y.	1,018	Bridgeport, Conn.	579
Reading, Pa.	694	Columbus, Ohio.	200
Louisville, Ky.	229	Newark, N. J.	1,040
St. Louis, Mo.	510	Paterson, N. J.	191
Portland, Ore.	193	New Orleans, La.	112
Fall River, Mass.	844	Los Angeles, Cal.	355
Minneapolis, Minn.	338	Springfield, Mass.	267
New York City, N. Y.	4,059	Flint, Mich.	250
Rochester, N. Y.	749	Waterbury, Conn.	113
Brockton, Mass.	289	Schenectady-Albany, N. Y.	197
St. Paul, Minn.	218	Detroit, Mich.	1,405
New Bedford, Mass.	553	Philadelphia, Pa.	687
Milwaukee, Wis.	598		
Richmond, Va.	167		
Perth Amboy, N. J.	160		
Total of 8 cities reporting less than 100 each.	402		
TOTAL INCREASE IN 38 CITIES	41,455	TOTAL DECREASE IN 27 CITIES	25,186

Cost of Living *331.2*

The Cost of Living Increases 1.7 Per Cent

THE cost of living in the United States on September 1st was 1.7 per cent higher than during the month previous, according to figures collected by the National Industrial Conference Board (New York). The figures upon which the Board bases this statement are given in somewhat condensed form in Table 2. They show that the increase was due entirely to the rise in food costs, as this item increased within the month 4.3 per cent. On the other hand the price of clothing dropped 1.3 per cent. The average cost of the remaining items in the budget did not vary. Living costs are now 64.8 per cent above the levels of 1914, as is shown by curve B of Fig. 2.

In the same figure curve C shows the variations in the cost of the 22 articles of food which are consumed by the average American family. These food prices are for the 15th of the preceding month, and are compiled by the U. S. Bureau of Labor Statistics, and used by the Conference Board in making up the total figures on the cost of living. Attention is also directed to curve A of Fig. 2, which shows the per cent changes in the cost of living as reported by the U. S. Bureau of Labor Statistics. This curve is made up of the weighed items of food, clothing, housing, fuel and light, and furniture and furnishings.

As a still further indication of the trend of cost of living, Fig. 3 and Table 3 are presented. The table gives the index numbers of wholesale prices by groups of commodities for the months of July and August, while the curve shows the movement in index numbers since January, 1915, for all commodities. As both table and chart clearly indicate the trend is now up-

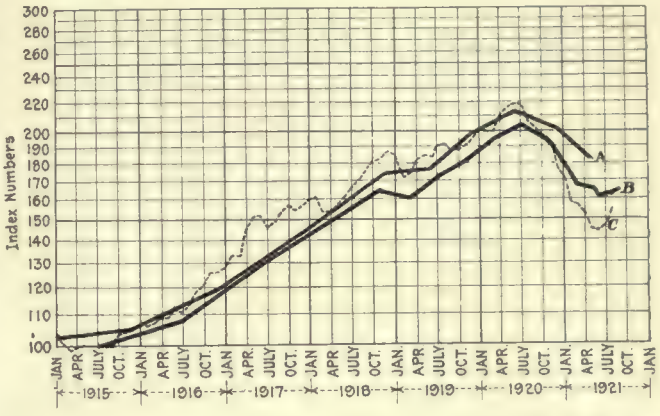


FIG. 2 THE TREND OF COST OF LIVING IN THE UNITED STATES
Curve A—As Reported by the U. S. Bureau of Labor Statistics.
Curve B—As Reported by the National Industrial Conference Board.
Curve C—Retail Prices of 22 Articles of Food as Reported by the U. S. Bureau of Labor Statistics.

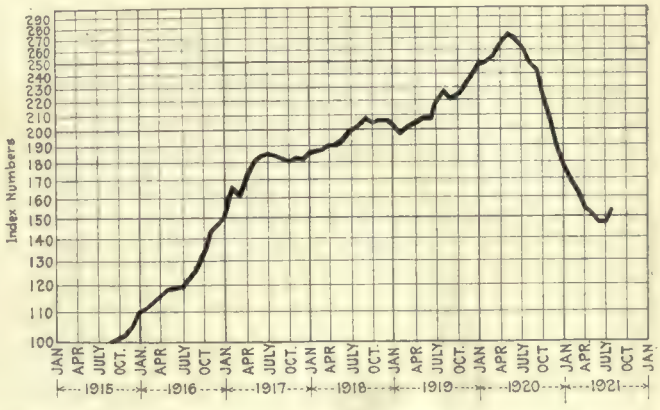


FIG. 3 THE TREND OF WHOLESALE PRICES IN THE UNITED STATES:

TABLE 2. PER CENT CHANGES IN THE COST OF LIVING IN THE UNITED STATES AUGUST TO SEPTEMBER, 1921
(Compiled by the National Industrial Conference Board)

ITEM	RELATIVE IMPORTANCE IN FAMILY BUDGET PER CENT	PER CENT INCREASE ABOVE AVERAGE PRICES IN JULY 1914 and		PER CENT CHANGE AUGUST TO SEPTEMBER
		AUGUST 1921	SEPT. 1921	AUGUST 1921
Food	43.1	48*	55*	4.3 increase
Shelter	17.7	69	69	No change
Clothing	13.2	59	57	1.3 decrease
Fuel and light	5.6	79	79	No change
(Fuel)	(3.7)	(91)	(91)	(No change)
(Light)	(1.9)	(55)	(55)	(No change)
Sundries	20.4	83	83	No change
Weighted average od all items	100.0	62.0	64.8	1.7 increase

*Food price figures are for the 15th of the preceding month, from the United States Bureau of Labor Statistics.

ward, and as measured by the Bureau's weighted index number, food articles in the aggregate are nearly 16½ per cent higher in August than in the month previous, while farm products, which includes many food products in the raw state, are 2½ per cent higher. In all other groups, excepting cloths and clothing, which show no change in general price levels, decreases took place ranging from 1 per cent in the case of building materials to 4 per cent in the case of metals, while all commodities were approximately 2¾ per cent higher in August than in July.

TABLE 3. INDEX NUMBERS OF WHOLESALE PRICES, BY GROUPS OF COMMODITIES FOR JULY AND AUGUST, 1921

(Compiled by the United States Bureau of Labor Statistics. Base Year 1913=100)

Commodity Group	July	August
Farm products	115	118
Food, etc.	134	152
Cloths and clothing	179	179
Fuel and lighting	184	182
Metals and metal products	125	120
Building materials	200	198
Chemicals and drugs	163	161
House-furnishing goods	235	230
Miscellaneous	149	147
All commodities	148	152

Wages *331.2*

The Trend of Industrial Wages

FURTHER wage reductions took place during August, according to reports of the U. S. Bureau of Labor Statistics, but despite this, because of increases in working time, average per capita earnings were generally higher than during the month of July.

A somewhat condensed presentation of the data relating to wage trends as compiled by the Bureau is given in Table 4, the average earning reported for the months of July and August being obtained by dividing the total amount of the payroll by the number of employees on the payroll during that particular month. The index numbers given in the last two columns are computed on the basis of 1919 figures as equal to 100.

As shown by the table average earnings decreased in but three of the 13 industries reporting; the automobile industry dropping from $33.12 per week in July to $32.00 in August; cotton manufacturing from $16.89 per week to $16.40; and cotton finishing from $22.16 per week to $21.70.

The trend of wages in these three industries, as reported monthly by the U. S. Bureau of Labor Statistics since January, 1920, is graphically shown by the curves of Fig. 4. Fig. 5 shows the trend in other of the industries listed in the same table.

A short abstract of the Bureau reports on changes in wage rates and per capita earnings follows:

Iron and Steel. Six establishments reported a 20 per cent decrease, affecting the entire force in 3 establishments, 98 per cent of the force in two establishments and 60 per cent of the force in the remaining establishment. All men in seven mills had wage-rate decreases ranging from 10 to 20 per cent. A wage-rate reduction of approximately 19 per cent was made to all the men in four plants and to 90 per cent of the men in a fifth plant. The entire force in three establishments had wage reductions which amounted to 15 per cent in two plants and from 10 to 15 per cent in the third plant. Twelve establishments reported a wage decrease of 10 per cent. This decrease affected the entire force in 5 plants. In five other plants, 95 per cent, 60 per cent, 55 per cent, 20 per cent, and 10 per cent of the forces were affected, respectively; while in two other plants the number of men affected was not stated. Nine establishments discontinued paying time and one-half for over eight hours work. Due to more time being worked throughout the industry, the per capita earnings are 10 per cent more for August than for July.

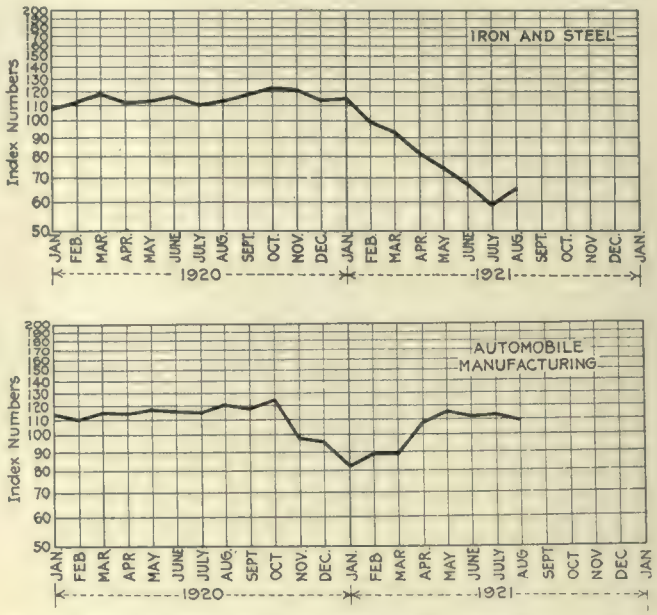

IRON AND STEEL
Index Numbers
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC. JAN.
1920
1921
AUTOMOBILE MANUFACTURING
Index Numbers
JAN FEB MAR APR MAY JUNE JULY AUG. SEPT OCT NOV. DEC. JAN FEB MAR APR. MAY JUNE JULY AUG SEPT OCT NOV DEC JAN
1920
1921

FIG. 4 THE TREND OF WAGES IN THE IRON AND STEEL INDUSTRY AND IN AUTOMOBILE MANUFACTURING

Automobiles. In two plants a decrease of 15 per cent in wage-rates was made, affecting all employees in the first plant and 75 per cent of the employees in the second plant. Five per cent of the men in two establishments were reduced 10 per cent in wages. When comparing the per capita earnings for August with those for July, an increase of 2.3 per cent is shown.

TABLE 4. AVERAGE EARNING IN SELECTED INDUSTRIES DURING JULY AND AUGUST, 1921

(Based on Figures Compiled by the U. S. Bureau of Labor Statistics. Base Year 1919=100)

Industry	Period of Payroll	Average Earning During		Index Numbers	
		July 1921	August 1921	July 1921	August 1921
Iron and steel	½ mo.	$38.47	$42.50	59	65
Automobiles	1 wk.	33.12	32.00	113	109
Car-building and repairing	½ mo.	59.33	60.40	105	107
Cotton manufacturing	1 wk.	16.89	16.40	100	98
Cotton finishing	"	22.16	21.70	108	106
Hosiery and underwear	"	15.43	17.00	97	107
Woolen	"	22.52	22.40	112	112
Silk	2 wks.	42.59	43.00	116	117
Men's clothing	1 wk.	31.35	33.40	123	130
Leather	"	22.07	22.80	95	99
Boots and shoes	"	22.48	24.15	105	112
Paper making	"	24.26	24.70	107	109
Cigar manufacturing	"	18.61	19.10	108	111

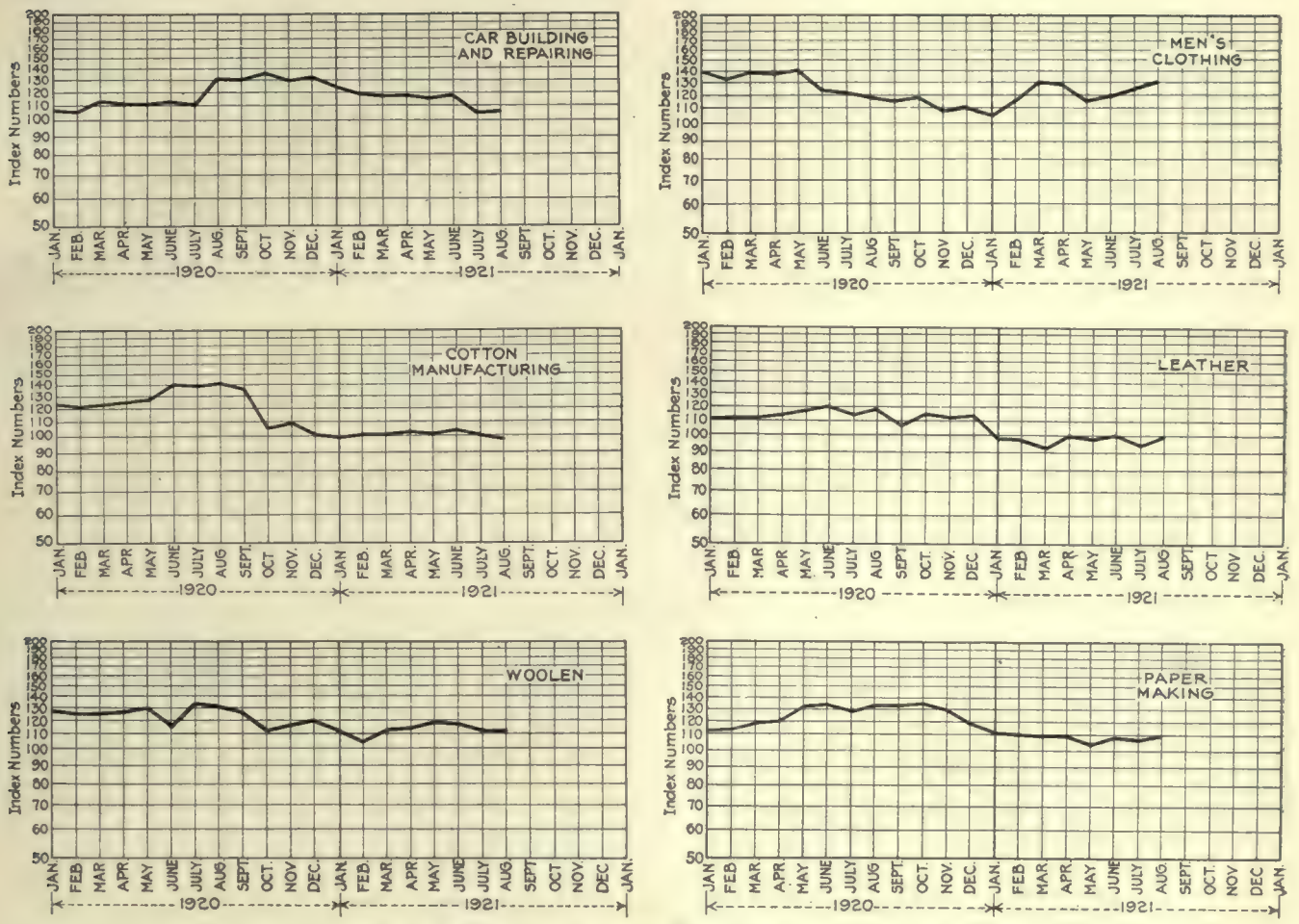


FIG. 5 THE TREND OF WAGES IN SIX AMERICAN INDUSTRIES

Car-building and Repairing. In four plants, wage-rate reductions of 15 per cent were made, affecting the entire force in three plants and 95 per cent of the force in the remaining plant. Three concerns reported a wage decrease of 10 per cent to all employees. A decrease of 1.2 per cent was made to approximately 70 per cent of the employees in one establishment. More time was worked during this pay-roll period and the per capita earnings show an increase of 2.6 per cent.

Cotton Manufacturing. The wages of 98 per cent of the employees in one plant were decreased 10 per cent. The per capita earnings for August, 1921, show a decrease of 3.3 per cent when compared with July, 1921.

Index numbers *338(026)*

Industrial Index Numbers

THE tables and charts given on the two pages which follow visualize the major trend in industry since January, 1920. They are part of a more complete and exhaustive presentation issued by the Department of Commerce in the form of monthly reports, which cover not only the movements of industrial products but also agricultural products, foreign trade, and banking and finance.

The numerical data and index numbers given in the tables are compiled by the Department from data collected by various bureaus of the government, trade associations, trade journals, etc., the value of the compilation lying in the fact that there is thus brought together in one place considerable data formerly widely scattered.

In computing the relative index numbers the attempt has been made to use the average of the year 1913, as a base equal to 100. In many instances, however, the basic statistics do not go back to the pre-war years, and in such cases averages for the year 1919 have been taken as a base. In a few cases still other base years have been used for special reasons.

In general, however, the tables compare the index number for the last month available, usually July, 1921, with the number for the preceding month. When other months are used, the fact is indicated by the following:

(1) The figures given compare August, 1921, with July, 1921.
(2) Comparison is for June, 1921, with the preceding month.
(3) The latest data available are for May, 1921. The comparison is between this month, April, 1921.
(4) In data collected quarterly the figures compare the June, 1921, quarter with March, 1921.
(5) Figures represent percentage of active to total machines reported for August, 1921, July, 1921, and August, 1920.
(6) Data on knit goods represent percentage of normal production for June, 1921, and May, 1921.

TABLE 1. PAPER

Item	Numerical Data		Base Year	Index Numbers	
	June 1921	July 1921		June 1921	July 1921
PRODUCTION: (Fed. Trade Com.)					
Newsprint paper, tons	86,770	94,247	1919	76	82
All other paper, tons	316,887	276,182	1919	[2]79	69
STOCKS: (Fed. Trade Com.)					
Newsprint paper, tons	26,629	25,519	1919	111	107
All other paper, tons	262,158	254,025	1919	122	118

TABLE 2. LEATHER PRODUCTS

Item	Numerical Data		Base Year	Index Numbers	
	June 1921	July 1921		June 1921	July 1921
PRODUCTION:					
Sole leather, sides (Tanners Council)	1,521,521	1,431,373	1919	81	76
Oak and Union harness; stuffed sides (Tanners Council)	57,196	44,971	1919	60	47
Finished belting, lb. (Dept. of Comm.)	26,122,000	.....	*c*1920	[2]105	[2]109
CONSUMPTION:					
Sole and belting, lb. (Dept. of Comm.)	16,901,000	.....	*c*1920	[2]118	[2]116
Harness welting, lb. (Dept. of Comm.)	1,501,000	.....	*c*1920	[2]110	[2]120
STOCKS AT END OF MONTH					
Sole and Belting lb. (Dept. of Comm.)	197,206,000	.....	*c*1920	[2]135	[2]130
Harness welting, lb. (Dept. of Comm.)	19,453,000	.....	*c*1920	[2]136	[2]136

c September.

TABLE 3. TEXTILES

Item	Numerical Data		Base Year	Index Numbers	
	June 1921	July 1921		June 1921	July 1921
WOOL:					
Consumption, lbs. in grease equivalent (Dept. of Agri.)	58,706	53,346	1913	145	132
Quarterly stocks lb.: (Dept. of Agr.)					
Commercial	443,326	.....	1919	[4]106	[4]99
Government	46,559	.....	1919	[4]34	[4]27
Number of spindles, (Dept. of Comm.)					
Active woolen	1,824,000	1,829,000	....	[5]80	[5]79
Active worsted	2,129,000	2,132,000	....	[5]90	[5]87
Number of looms (Dept. of Comm.)					
Active wide	49,415	51,008	....	[5]81	[5]80
Active narrow	13,600	13,776	....	[5]75	[5]74
Active carpet	4,027	4,230	....	[5]49	[5]50
COTTON:					
Consumption, bales (Dept. of Comm.)	461,656	410,120	1913	96	85
Stocks on hand in mills, bales, (Dept. of Comm.)	1,204,572	1,115,847	1913	90	83
Stocks, warehouse, bales, (Dept. of Comm.)	4,306,236	3,724,512	1913	245	212
Spindles, active cotton (Dept. of Comm.)	32,665	32,446	1913	108	107
Fabric consumed by tire manufacturers (Rubber Asso. of America)	8,044,486	.....	*a*1920	[2]321	[2]323
SILK:					
Consumption, raw bales (Silk As. of America)	33,846	32,325	1913	113	107
Stocks at end of month, raw bales, (Silk Asso. of America)	15,521	17,886	*b*1920	24	28
TEXTILE MANUFACTURERS					
Production underwear (Knitgoods Manufacturers of America)	559,591	.....	....	[5]55.4	[5]65.5

[1] Figures compiled from monthly reports on consumption by mills.
a November.
b February.

TABLE 4. RUBBER

Item	Numerical Data		Base Year	Index Numbers	
	June 1921	July 1921		June 1921	July 1921
IMPORTS, crude, lb. (Dept. of Comm.)	34,624,748	27,647,874	1913	359	286
CONSUMPTION by tire manufacturers, lbs.	21,207,555	.....	*a*1920	[2]436	[2]446
AUTOMOBILE TIRE Production: (Rubber Assoc. of America)					
Pneumatic tires	2,313,265	.....	*a*1920	[2]323	[2]356
Solid tires	28,395	.....	*a*1920	[2]165	[2]133
Inner tubes	2,359,928	.....	*a*1920	[2]298	[2]318
AUTOMOBILE TIRE STOCKS (Rubber Assoc. of Am.)					
Pneumatic tires	4,154,456	.....	*a*1920	[2]76	[2]71
Solid tires	240,336	.....	*a*1920	[2]89	[2]80
Inner tubes	3,835,098	.....	*a*1920	[2]77	[2]63

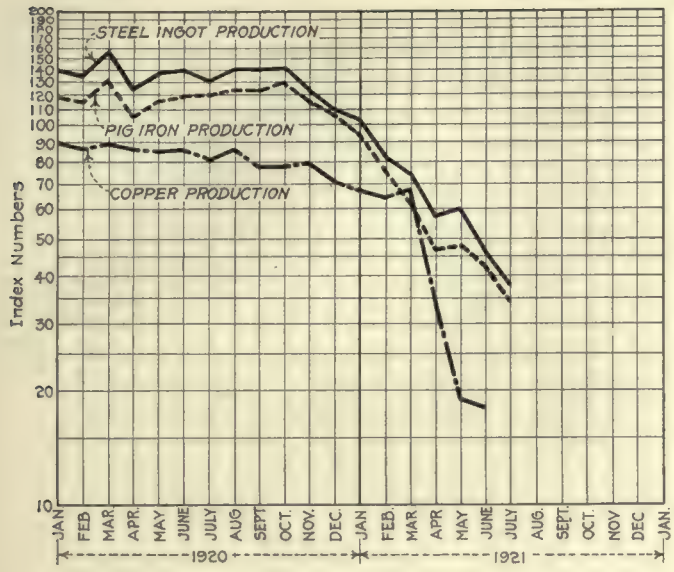
a November.

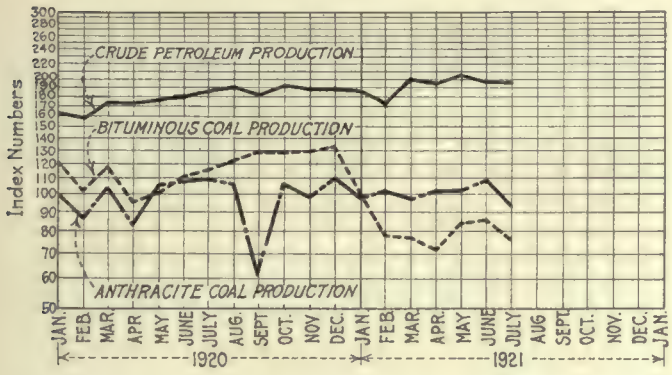
TABLE 5. METALS AND METAL PRODUCTS

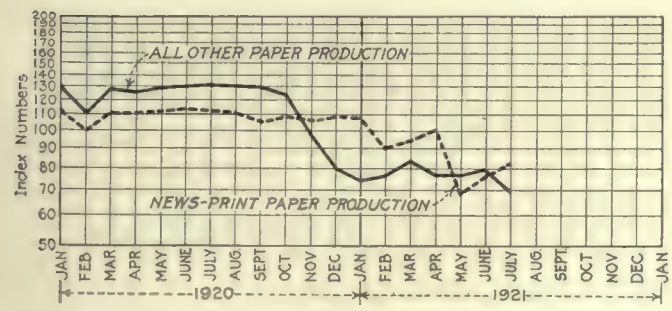
Item	Numerical Data		Base Year	Index Numbers	
	June 1921	July 1921		June 1921	July 1921
IRON AND STEEL:					
Iron ore movement at Sault Ste. Marie Canals, short tons (War Dept. Eng. Corps)	6,640,152	4,356,760	1913	124	83
Production:					
Pig iron, tons, (Iron Age)	1,064,833	864,555	1913	42	34
Steel ingot, tons (Am. Iron and Steel Ins.)	1,191,690	954,120	1913	47	38
Unfilled orders, tons (U. S. Steel Corp)	5,117,868	4,830,324	1913	87	82
COPPER:					
Production, lb. (Eng. and Mining Journal)	24,623,693	.....	1913	[2]18	[2]19
ZINC:					
Production, tons, (Am. Bureau of Metal Statistics)	19,443	.....	1913	[2]62	[2]67
Stocks, tons (Amer. Bureau of Metal Statistics)	89,889	.....	1913	[2]211	[2]271
TIN:					
Stocks, tons (N. Y. Metal Exchange)	2,546	2,521	1913	138	136

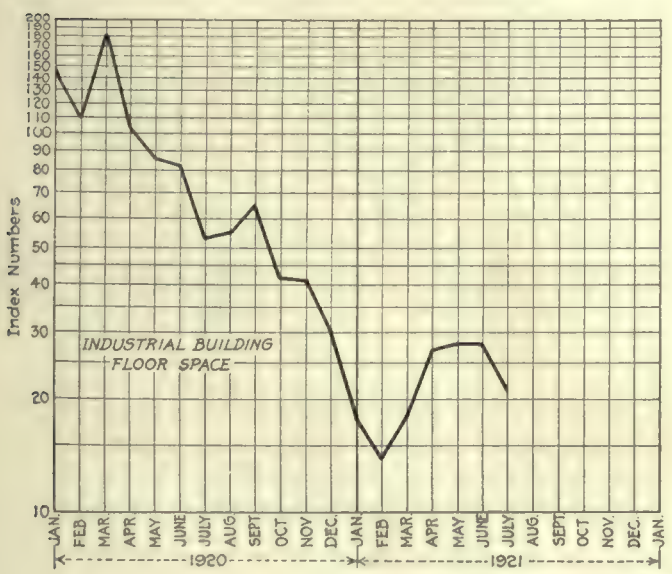
TABLE 6. FUEL AND POWER

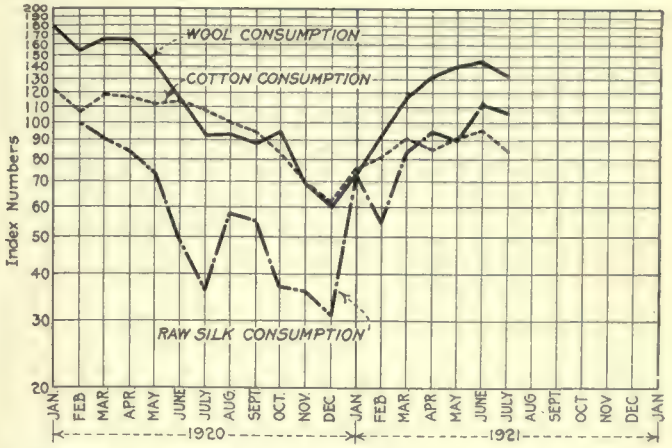
Item	Numerical Data		Base Year	Index Numbers	
	June 1921	July 1921		June 1921	July 1921
COAL AND COKE PRODUCTION:					
Bituminous coal, net tons (Dept. of the Int.)	33,852	30,394	1913	85	76
Anthracite coal, net tons (Dept. of the Int.)	7,786	7,050	1913	108	92
Beehive coke, net tons (Dept. of the Int.)	232	181	1913	8	6
By-product coke, net tons (Dept. of the Int.)	1,410	1,285	1913	133	121
PETROLEUM AND GASOLINE:					
Crude petroleum; (Dept. of the Int.)					
Production, bbl	40,405	40,228	1913	195	191
Stocks, bbl	161,048	167,215	1913	153	159
Consumption, bbl	42,797	41,570	1913	197	191
Gasoline: (Dept. of the Int.)					
Production, gal	430,344	.....	1919	[2]136	[2]130
Domestic consumption, gal	445,025	.....	1919	[2]124	[2]155
Stocks at end of month, gal	750,644	.....	1919	[2]169	[2]159
ELECTRIC POWER PRODUCTION:					
Central station, kw-hr. output (000 omitted) (Electrical World)	2,660,883	.....	1919	[3]117	[3]119

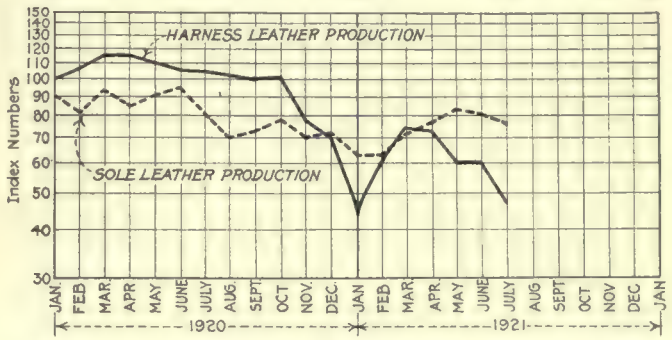


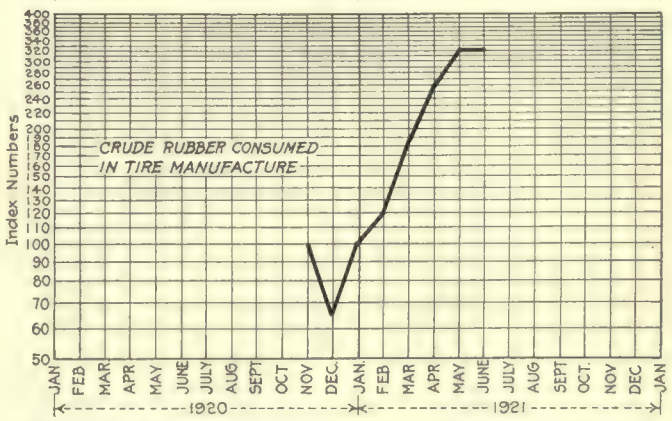












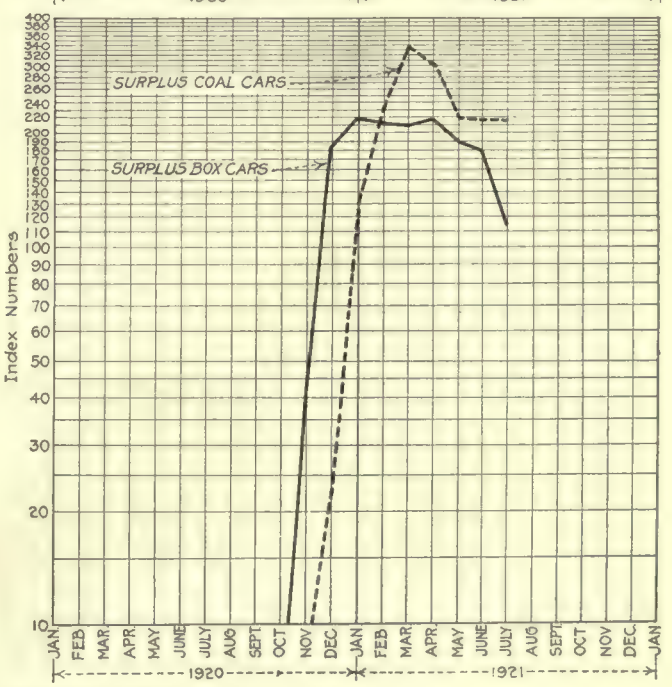


FIG. 6 THE TREND OF INDUSTRIAL MOVEMENTS SINCE JANUARY, 1921

MANAGEMENT ENGINEERING

THE JOURNAL OF PRODUCTION

L. P. ALFORD, *Editor*
E. W. TREE, *Associate Editor*

Published Monthly by The Ronald Press Company, 20 Vesey Street, New York

A Jolt

THE chances are nine to one that you who read these paragraphs are an engineer or an executive in responsible charge of work in industry. What follows may jolt you. If it does, may it set your ideas right. On the other hand, if you do not deserve such a mental jab, you will be unharmed.

What is your attitude toward the study of management? If you are antagonistic, so much the worse for you. Not only is a new concept of management here, and here to stay, but such a concept is already an essential to the man who is to get results in industrial and engineering work. For your own self-interest you cannot afford to ignore it. If you do not learn what it is and what its principles are, so that you can apply them in your everyday work, then others who are already applying them will pass ahead of you and take the success that might be yours. Do not doubt the truth of this statement. Do not fail to see that it vitally affects you. Do not hesitate, but believe and act for your own good.

You may be inclined to regard "management" as incidental, as a frill to be added when you have time. You are wrong. It is a part of the work you are doing daily if you have any executive or managerial duties. If you plan any work for others you are using management. If you are giving any orders for others to follow you are using management. If you are in any way responsible for the efforts of others, you must use management. Just as soon as you cease to work all by yourself, or under the direct detailed orders and instruction of another, at that moment you need a knowledge of management.

It does not matter how extensive or excellent your technical education or practical training may be, you are still unfitted for managerial work if you have failed to keep up with the development of management knowledge as a science and its practice as an art.

The increase in our knowledge of what to do and skill in doing what has been determined has been amazing during the past five years. The creative effort that always follows a great upheaval will soon be felt as we get farther away from the years 1917-1918, and one result will be an undreamed advancement in management during the present decade.

How much do you really know about management?

How well prepared are you to do your part in engineering and industry in the immediate future?

Do not deceive yourself. If you are in industry, lack a knowledge of management and fail to learn it now, others will soon have the place that you desire.

The New York Times discussing editorially some of the addresses delivered at the recent meeting of chemists in this city seems to believe that "a speedy return of prosperity lies in the intensive development of chemistry" and the "chemists must develop means of increasing production and decreasing costs." This is to be done by utilizing "catalytic action," and a catalytic agent is defined as something that speeds up "productive activity without self-change or exhaustion."

"Without self-change or exhaustion!" Are we being introduced to a new arrival, or, are we but meeting again after a chemical bath, rubdown, shave, hair-cut, and massage, our ancient acquaintance, Perpetual Motion?

The Unemployment Conference

ONE of the lines of influence which brought about the appointment of the President's Conference on Unemployment is said to be the engineers' report on industrial waste. Be that as it may, that report declared unemployment to be one of the major sources of waste and loss in industry, and brought forth the startling fact that at no time during the past 20 years has the margin of unemployment been less than 1,000,000 men. This margin is fairly permanent in good times. Seemingly, one worker out of every 40 is always out of work, and just now four or five others are believed to be keeping him company. Figures gathered during the past month are a bit reassuring; but the improvement may be only temporary, for the demand for agricultural labor is at its peak during the harvest season.

The problem that the conference has attacked has two major aspects. It involves research, and its relief must come principally from economic measures. Extensive research must be conducted, for we have no reliable statistics as to the extent of unemployment in the United States today. The best figures are those compiled by the United States Employment Service; but these are restricted, for they are drawn from the pay-roll records of only 1,428 industrial plants. The last census shows that we have 288,376 industrial establishments in the United States.

Before an attempt is made to survey the unemployment in this country today, the conference must frame an acceptable definition of employment, and its opposite, unemployment. A mere adding together of the numbers of men and women now on the pay-rolls of industrial plants and comparing the total so found with the total number previously employed, say on January 1, 1920,

would yield but a worthless comparison. It is known that many women who went into industry under the stress of war conditions have now returned to their normal work in the home. They are unemployed so far as industry is concerned, but are employed so far as the work of the nation is concerned. A number of men have also left industry for other work from which they were drawn by the demand for war workers. They too, are unemployed today so far as industrial records show, but are nevertheless at work.

It is hardly to be hoped that a comprehensive survey can be conducted, even by this conference on unemployment, for it would be a task nearly as great as the taking of a national census. To yield the maximum of facts it should show how many men and women are unemployed who are without dependents; how many have dependents; how many have been committed to prisons, penitentiaries and other institutions of correction; how many have been received into asylums for the insane and sanitariums for the incurable; how many are chronic loafers who will not work; how many are earning a living—if it can be so called—by catering to the vicious appetites of others; how many have paid their working debt through long years of industry and are now entitled to the "afternoon of life"—in short, facts which would give us a true economic evaluation of the employable, unemployable, employed, and unemployed man- and woman-power of this country.

In the second place, the problem is economic, for its solution cannot be found in panaceas and make-shifts but will only be discovered in sound economic measures which will so change conditions as to lead automatically to the recovery of industry, business, and commerce.

What little improvement in business conditions we have seen during the past few months which has reacted slightly to decrease unemployment, has been stimulated by a readjustment of prices. Until this readjustment has run its course, high prices will continue to be a deterrent influence. The need of hastening the process as an economic measure leads to these suggestions: Reduce the book value of all material of manufacture on hand or on contract to the basis of current prices. Charge all material in goods-in-process or in finished stock at current prices in determining manufacturing costs. Reduce all selling prices in keeping with the lower prices of material, and also in keeping with possible economies in production and sales.

There is little support among responsible persons for the reactionary suggestion to "liquidate labor." But labor, to whose ranks the employed and unemployed belong, must assist in improving its own condition. Two ways are: check all efforts to increase wages at the present time; do all possible to increase unit production—per man, per machine, per hour.

In a problem of such nation-wide importance the public also has a duty. Like every other habit, the habit of work can be broken, and one who has been industrious for years can drift into a condition of mind that will render him unemployable. This degenerating process can be hastened by yielding to some of the great popular tendencies in our national life. These the public must combat through church, school, and press. Public interest must be aroused to overcome the appetite for pleasure, the aversion to work, and the shirking of responsibility.

Like all human gatherings, the success of the conference will depend upon the spirit in which it does its work. Secretary Hoover has said that contentious questions are to be barred, but no one has said that the spirit of service is to prevail. And yet far-sighted engineers and statesmenlike industrialists have declared time and time again that we will never work through our industrial difficulties until industry shall be actuated by the spirit of service, until its permanent function shall be the production of goods with a minimum expenditure of material, time, and human effort.

Any factory executive can see waste in wages paid to a workman for sitting on a bench, smoking a pipe and doing nothing. Many such executives fail to see waste in interest on capital tied up in idle plant, idle material, and idle product when paid to a banker, sitting behind a mahogany desk, smoking a good cigar and doing nothing.

Language as a Tool

HOW generally do we realize that one condition of the successful application of engineering to the direction of human energies is a systematic study of the conditions and procedure of conveying thought from one mind to another—of language.

Engineers have too often thought of the phenomena of language as matters for the publicity man and the spellbinder to play with, but regarding which they themselves, working with the realities of natural forces, had little concern. They have too often forgotten that language is itself a most serious problem of "transportation." One distinguished engineer, indeed, when urged to modify slightly the arrangement and wording of one of his reports, to make it more readily intelligible to his clients, replied stiffly that having set his thoughts down in logical form he was through; those who wished to understand could study them out. That man had not even put his goods on the car.

We are not so much concerned here with the more elaborate and formal writing and speech-making required of all men in positions of responsibility. That might be called the passenger side of the transportation service of language. It is of great importance. We may regret that the engineer has not more generally given it his attention. We may wonder for example, how much our body politic has lost from the fact that men like Mr. Hoover have too generally neglected the development of the power of public speech, while men like Mr. Bryan have not. But after all, it is the freight service that counts, in the transportation of the world's thought no less than of its food, fuel, and material. The great problem of language is its use by ordinary people for the expression of ordinary ideas on ordinary occasions. In connection with this problem the engineer can be of very special service.

Management engineering involves understanding and co-operation among multitudes of workers. Unless there is ready, accurate and tactful command of speech and writing among both superiors and subordinates in the world of industry, the world's work is impeded at every point. How much attention has society given to insuring such general command of its medium of communication? Consider two typical cases:

For a thought to "carry" to the minds of others it must be readily intelligible to the persons addressed. Much of the misunderstanding and delay in getting the world's work done is attributable to careless explanation.

In connection with a construction job the instructions which the foreman was supposed to give to the men were transmitted to him in writing as follows:

> Discontinue dumping surface dirt on the edge of Sand Pit Number 2. All refuse must be carted away to dump and deposited in accordance with previous instructions. Men are requested to follow this rule carefully and foremen are required to enforce it.

Here is the way in which those instructions were passed on by one of the foremen:

> Pit 2, don't dump, cart to dump, orders, see?

The result was confusion. The foreman spoke in a hurry, rushed away and left the men within range of his voice to figure out what he meant. Here is what happened:

Some of the men stopped taking sand from Pit Number 2. Others insisted that they were supposed to scoop sand and pile it up along the side of the pit. Others that they were to haul sand from the pit to the refuse dump; others that the sand pit was to be abandoned. All of the things referred to were attempted by the men until someone discovered the condition and reported it.

But clearness alone is not enough. Moreover, saying too much is as fatal to successful transportation of your idea as saying too little. At a recent convention of business executives the sales engineer of a leading plant made an informal address which was admirable in content, form, and delivery. He gave his audience for almost the first time a clear and satisfying view of a little understood subject. In the session which followed, however, this same man utterly destroyed the impression he had made. He kept putting in his oar. What he said was always incisive and well turned, but the chief result of his day's activities was that the enthusiastic listeners of the morning were rendered thoroughly unwilling to follow any course he might advise. As a solution of a problem of transportation his use of language was not much more successful than that of the clumsy construction gang foreman.

Our difficulties grow out of the general assumption that command of language for practical purposes comes by nature. The very opposite is the fact. Language as we have inherited it is a complex, baffling medium—no algebra but at the best a sort of picture writing. To make full use of it, so as to convey ideas accurately, briefly and without misrepresentation or friction involves ceaseless care. It involves listening to other people. It involves experimenting and practicing for oneself—a study which must be carried on, not in speial "classes" but in connection with a man's daily business.

There are few ways in which the engineer, with his peculiar training, could render a more far-reaching benefit to society than by first showing the individual the importance of strict respect for the procedure and customs of language, and then by aiding society towards a wise standardization of language procedure, so as to reduce its complexities without sacrificing its life.

In fact, for the accomplishment of the special ends of the management engineer, reliable command of language on the part of the industrial community is a necessity. In the effort to eliminate waste from the world's industry, one pervasive waste that cannot be neglected is the bungling use of the medium of human communication on the part of either foreman, executive, or engineer who gums up the work on which he is engaged by soliloquizing when he thinks he is talking.

For a long time we have heard about increasing the efficiency of labor, and increasing the efficiency of machinery. Now those who believe the old adage, "All good things come in threes," and those others who like a trilogy of associated ideas, will be pleased to read in this issue about the possibilities of increasing the efficiency of capital.

The Slowness of Progress

HERE and there one is tempted to point out the shortcomings of others and to lament the lack of a truly progressive spirit in industry. The burden of much of this complaining today is that many owners and managers of industrial plants do not know what they should do in the present period of industrial stagnation, and whom they should employ, to better their product, or equipment, or methods of manufacturing, and so prepare for coming business.

There is nothing new or surprising in such comments; but unfortunately much that is true. Nearly one hundred years ago Charles Babbage in "Economy of Machinery and Manufacturers" charged engineers with failing to examine the work of others, to acquire a knowledge of their art, and to draw from the great experience of the past:

> "There is, perhaps, no trade or profession existing in which there is so much quackery, so much ignorance of the scientific principles, and of the history of their own art, with respect to its resources and extent, as is to be met with amongst mechanical projectors."

Even in the case of those who do appreciate the full value of newer methods and mechanisms there are limitations. One is found in the fact that many a small or medium-size plant cannot afford to spend the money necessary to put in refinements. The betterments simply will not pay for themselves because of the small volume of product. Another is found in the present condition of business where the wise manager properly hesitates

to increase his investment or to reduce his amount of available cash before he sees the turn of the tide and the return of active demand.

These reasons govern in many cases. Failure to act, hesitancy to adopt the new, must not always be interpreted as a lack of knowledge or as a failure to appreciate the improvements that have come from the more recent discoveries and experience.

And such limitations whether of circumstances or of mental attitude must not be permitted to bring discouragement. True progress is always slow. This is particularly so of science and the child of science, engineering. A New Englander who knew far more about the great world around us than the average man, who was never thought of as an engineer but who might almost be claimed by the engineering profession, for he earned his living as a land surveyor nearly a century ago, saw the slow growth of science and wrote:

"You can hardly convince a man of an error in a life-time, but must content yourself with the reflection that the progress of science is slow. If he is not convinced, his grandchildren may be."

Thoreau might have said, drawing his figure from the woods he loved so well, that the development of science resembles the growth of the mighty oak.

BOOK REVIEWS

Management engineering 658
Personnel management 658.4
Cost accounting 657.524

FACTORY ADMINISTRATION AND COST ACCOUNTS

By Edward T. Elbourne
Publisher, Longmans, Green & Company, New York

REVIEWED BY H. W. MAYNARD
Cost Accountant, Scovell, Wellington & Company

IF this volume had been written two hundred years ago it might have had a sub-title, "A Complete Treatise for Factory Managers and Officials, including Administration and Factory Organization Methods, Plant Layouts, and Control of Production, Labor and Material, Together with a Broad Statement of Administrative Records and the Necessary Cost Accounting, including the Means of Interlocking Factory Cost Accounts with the General Books." The work is English, and its scope is broad.

The book is a revision of a previous one. Mr. Elbourne's comments on the revision are interesting in their reference to the industrial changes of the last few years. He says:

"When the time came for making revisions for the seventh reprint of the author's previous work, 'Factory Administration and Accounts,' first published in April, 1914, he had to recognize that industrial conditions had permanently changed and that the pre-war outlook was not adequate to present-day conditions. For example, costing had become an admitted necessity if competition was to be faced with any assurance of ultimate commercial success, and its inter-relation with the achievement of production efficiency had become increasedly clear. Production efficiency itself, as a consequence of universal manufacturing for war purposes, had acquired a new significance. Then, again, the relations of Labour with Management and Capital had undergone such a change as to create virtually a new phase altogether. These various considerations left the author no option but to start entirely afresh and on foundations of the previous work to reorganize and re-write the whole subject from beginning to end."

The general treatment is masterly, and is worthy of the book's broad range. There is every evidence of painstaking care. A surprising number of subjects is dealt with, some more and some less exhaustively, as becomes their relative importance. Particular attention is devoted to the details of cost accounting procedure. There is scarcely a phase of factory administration and factory cost accounting concerning which the book does not give definite, if sometimes general, information. The book is divided into seven sections:

I. General Administration, including the organization and control of the staff, and policies of the company and of the sales department.
II. Production Control, which includes among other subjects an excellent statement of production estimating the rate fixing.
III. Labor Administration, including industrial relations.
IV. Material Control.
V. Administrative Records, covering records of labor, material and plant, the distribution of cost and the finished cost reports.
VI. Cost Accounts, including the relation of the cost accounting to the financial books, the distribution of burden and the allocation of material, labor and burden to costs, with the various accounts required and the corresponding reports.
VII. Specimen Forms. A large number of forms for all purposes with complete cross references to other forms and to points in the text from which references are made.

Mr. Elbourne's attitude toward industrial relations is delightful. He possesses a breadth of view and a saneness which, while not new to America, seem to have been less completely developed in the more arbitrary English factories until the change in the conditions arising from the late war. Mr. Elbourne suggests as a member of the staff a "labor co-ordination officer," a title which he abbreviates to "L. C. O.," who would exercise the functions of employees' welfare, employment and similar duties and at the same time act to harmonize the interests of labor and management.

Mr. Elbourne's broad attitude appears also in his discussion of piece or premium job rates. He says:

"Rate fixing infers the fixing of rates for some system of individual payment by results, but this is too narrow a view to take of the application of the principles that ought to control rate fixing and to indicate a wider scope of the term *production estimating* has been adopted. Rate fixing can be defined as the application of production estimating to the fixing of job rates. This lifts the matter on to a higher plane as inferring analytical methods of measuring process efficiency and consequently of increasing output on lines quite distinct from the attitude of bargaining between the worker and the management. This viewpoint opens an enormous vista of possibilities in any works, and perhaps most in those where no system of payment by results exists. Such systems commonly operate to defeat real efficiency by perpetuating too low a standard of satisfactory performance —the penalty paid for want of knowledge of the proper methods of production estimating."

When writing of motion study, Mr. Elbourne says:

"When a large number of pieces have to be made or a large bulk of material handled, the cost of such investigation can be easily justified and, in the case of the use of tools of a new type, motion study may even be considered essential. As a practice, however, either due to want of tact on the part of the observer or the desire to take too much advantage of the results of the observations made, motion study is not popular in America and to an even less degree in this country. . . . It may be instanced that as a result of complaint made regarding the state of nervousness often resulting from observation being made, the American Government has forbidden its use in its own workshops."

Some objection may be taken to the last statement but there is no question as to the increasing unpopularity of motion study in this country.

The recording of workers' time on jobs, or "time-booking," is described in detail. Eight different methods are given, with the merits and defects of each. Some excellent comments are also given on the procedure for reorganization of routine, and the steps which must be taken before a change is actually started. Standardization is emphasized, not only for products, but for forms and methods. The specimen forms are ample and excellent, and there are full and clearly explained cross references to descriptive matter in the text and to associated forms.

Against the merits of a work so carefully designed, so complete and of so broad a scope, it is difficult to apply criticism. There are certain points, however, which must be commented on without detracting from the merits of the work as a whole. Many of the English expressions are strange and some are hard to get used to. One word which is rather trying is "oncosts," by which Mr. Elbourne designates burden or overhead. The use of this term is not new, but it is difficult to see either its appropriateness or desirability. Whether or not one term is better than another, it would be desirable to adopt, as far as possible, uniform technical terms throughout the English-speaking language.

Mr. Elbourne does not use the phrase "manufacturing cost" or any similar term to designate the total cost of material, labor and factory burden, but he uses "inclusive cost" as the cost to make and sell, in other words including allowances for selling and general administration. As in most English writings, the use of words is rather more definite and precise than is the custom in this country.

The section devoted to cost accounting includes a number of diverse elements and is arranged, in order of subjects, rather backward than forward. Most writers on this subject have fixed their attention mainly on metal working shops, and it is largely for this reason that cost accounting has not been until recently particularly appreciated in other industries. Mr. Elbourne describes the foundry and the "smithy" as examples of process costs, and these are tied in with the job order system which he exemplifies, but the difference between them is worthy of more comment than it receives.

Mr. Elbourne establishes the proper interlocking of factory cost accounts with the general or financial records by the establishment of three "works suspense" accounts, for material, disbursements (direct charges to orders) and wages. These are charged with the expenses and are credited with the corresponding cost of orders completed. The distribution and allocation of burden or "oncosts" are handled entirely in the financial ledger. The financial accounting department maintains what the author calls a cost ledger, which is not a cost ledger in the American sense of the term but is a detail ledger covering work-in-process. Mr. Elbourne says:

"The suspense accounts in the financial books are only credited on the strength of suitable evidence or returns from the works accounts office. Expenditure not allocated or not accounted for, that is, the outstanding balance on these suspense accounts—the difference, in fact, between the total debits and the total credits—remains, therefore, metaphorically, a liability of the works administration."

Mr. Elbourne's tabulation of certain accounts giving the source of the debits and the destination of the credits, is good. It would be improved by a diagram of all the factory cost accounts, showing the actual debit and credit entries. Some improvement might be made in the diagrams which he shows, and the idea might be expanded with benefit.

It is interesting to note that Mr. Elbourne agrees to the inclusion in production costs of the item of interest. He refers, however, to "interest on capital," and not to interest on the capital invested in plant equipment and inventories. Perhaps he means the same thing without exactly expressing it. His words are:

"Interest on capital is commonly not acknowledged as an item of production on costs, but as a matter of logical treatment, the hire of capital, being essential to production, should be recognized accordingly as a factor in cost of production. The payment of that hire cannot be evaded in the case of rent and debenture charges, but there is no morality in treating interest on other capital as an optional expense because dependent on profits. There is no real profit until that interest is paid. This connection has been recognized by the Federation of Master Printers in their standardized costing system."

Farther on Mr. Elbourne gives an ingenious method by which, if the financial managers object to charging interest to operating, the machine burden rates may be maintained in their proper relationship (including the difference in investment) without making the interest a subject of book entry.

Mr. Elbourne's treatment of burden or "oncosts" is rather too brief. He approves of the use of normal or standard burden rates, but since he apparently prepares financial statements only once a year, instead of every six months, or even every month, as is the case with many American factories, the difference between actual burden and the burden charged to cost is simply closed out in total at the end of the fiscal year. He apparently overlooks the fact that valuable lessons are to be learned by the study of the unabsorbed monthly balances. No reference is made to the use of standard or scheduled costs for material, labor, or burden and the analysis of the resulting variances.

It may be said as a whole that the statistics and reports shown are hardly adequate to the requirements. A cost accounting system is an elaborate machine which is intended to deliver a finished product in the form of statements or reports which will be useful not

only to the head cost accountant and the works manager but also to the factory superintendent, the foreman and the sales department, and the financial chief. There should be periodical statements showing the whole information of expenses and order costs, the movement of different kinds of major material, work in process and finished goods, the requirements for material against the visible supply plus commitments, and the value of the factory output as compared with the predetermined standard. Mr. Elbourne has generally indicated these, but it would have been enlightening if specimen forms of such reports had been shown.

Taken as a whole, Mr. Elbourne's work is a valuable contribution to technical knowledge and is a sound foundation on which a factory manager may build.

Workers, Training of 658.455
Industrial education 6(07)

EMPLOYEE TRAINING

By John Van Liew Morris

Publisher, McGraw-Hill Book Company, New York

REVIEWED BY JOHN T. FAIG

President, Ohio Mechanics Institute

THIS timely volume is a mine of information for school superintendents, principals and teachers of vocational subjects, as well as for presidents and general managers of companies that give instruction to their employees now, or that plan to give it in the future. The main body of the book is a compilation of interesting facts concerning the educational departments of 35 manufacturing establishments, chiefly in metal lines. The facts are simply expressed, the data well chosen and fairly presented. They are introduced by definitions and a statement of the methods of study of the details of the educational departments, which were obtained in personal visits by the author. Following the descriptions of the educational methods of the establishments visited is a series of discussions of considerable length on apprentice training, the training of technical men, and special training.

Such a volume is most welcome at this time. Many of the industries represented in the book were compelled to devise their own educational departments to supplement the training provided by public elementary schools, high schools, technical institutes, and engineering colleges. Since these have been continued by the companies at considerable expense, it is evident that they must be of value. The study of the data shown in the book should therefore be of great benefit to directors of vocational education. The schemes of education presented cover such varied lines and different kinds of employees that helpful suggestions will be found for almost any definite problem.

The author apparently underestimates the importance of the co-operative plan of education, that is, the plan under which persons study in a school and work in an industrial establishment in equal alternate periods. About two thousand young men in American universities are now following the co-operative plan, which was started about sixteen years ago at the University of Cincinnati. Four of the best known engineering colleges of the country have adopted the co-operative plan in whole or in part, and four other institutions of collegiate grade are following it.

The success of the plan in colleges brought about its introduction into many secondary schools. The increased number of years that must be spent in school under recent state laws makes possible a co-operation of school systems and industrial systems that offers great advantages, both as to effectiveness of instruction and economy of operation.

The comparatively slow growth of the co-operative plan is largely due to lack of trained executives to administer it, and this lack is now being supplied by graduates of the co-operative plan, who are themselves entirely familiar, not only with the possibilities of co-operative instruction, but also with the difficulties to be overcome in inaugurating it.

Educators and industrial leaders will be forced to some such co-operation and an adequate description of the mechanism already devised would appear to have its place in a volume on employee training. All this does not alter the fact that the book by Mr. Morris offers in compact form much valuable information, including pertinent facts about a large part of the successful vocational education that has developed in this country, and that these facts are presented in concise and understandable form.

Management engineering 658.4

PERSONNEL RELATIONS IN INDUSTRY

By A. M. Simons

Publishers, The Ronald Press Company, New York

REVIEWED BY WILLIAM M. LEISERSON

Impartial Chairman, Men's and Boys' Clothing Industry, New York City

"PERSONNEL RELATIONS IN INDUSTRY" is a discussion in a somewhat journalistic style of current developments in the field of industrial relations. The book is a summary, based largely upon the secondary material, of the principles bearing upon the various phases of personnel work. It is neither a narrative, historical account, nor a manual of detailed practices or methods. It would seem to be better suited for classroom use than to the needs of practical executives. The author covers comprehensively the field of industrial relations, quoting generously from the best literature on the subject. The scope of the work is indicated by the following chapter heads:

The Changing Viewpoint
Standardization of Employment Elements—The Job
Standardizing the Element—Human Nature
Sources of Labor Supply
Application Blank—References—Interviewing
Mental and Trade Tests
Introducing the New Employee
Interesting Labor in Industry
Training
Adjustments, Transfers, Promotions, Discharge

Working Environment—Welfare Work
The Wage Relation
Labor Turnover
Wider Social Control
Organization of the Personnel Department
Democracy in Industry
Forms of Joint Management
Union Contributions to Joint Management
British Experiments in Joint Management

The introductory chapter, while interestingly written, impresses one as including too much extraneous material. The author has fallen into this error again in his use of illustrations throughout the book. The five chapters devoted to a treatment of the employment elements are full of suggestive material. One cannot help wondering, however, whether the author, in relying upon secondary material, has not been misled into over-emphasizing such subjects as Job Analysis and Trade Tests. There is a disposition to treat as established realities practices which are as yet mere projects or, at most, in process of experimentation.

In the closing four chapters there is a particularly excellent discussion of democracy in industry and joint management. In Chapter X also there is an able discussion of the adjustment of grievances, and the handling of discharges, transfers, and promotions. While the book cannot be said to be an original contribution, it is valuable as a comprehensive summary of the best literature on the subject of industrial relations.

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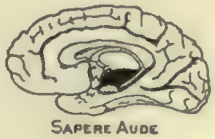

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MANAGEMENT ENGINEERING

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Decreasing Foundry Costs Through the Mechanical Handling of Materials

By J. M. MACRAE*

Chief Engineer, Cadillac Tool Company

WITH the demand for increased efficiency of recent years foundry experts were quick to recognize that the greatest step toward the saving of labor and the minimizing of operating expense in the foundry would be the mechanical handling of materials. Moving the various materials used in a foundry is no small task. It requires the employment of a large number of men; and in a conveyorless foundry "moving" is perhaps the principal work. On investigation of this problem it was found that instead of having each workman move his work by hand from one point to another the man's capacity could be increased many times by stationing him at one point and then bringing all of his work to him.

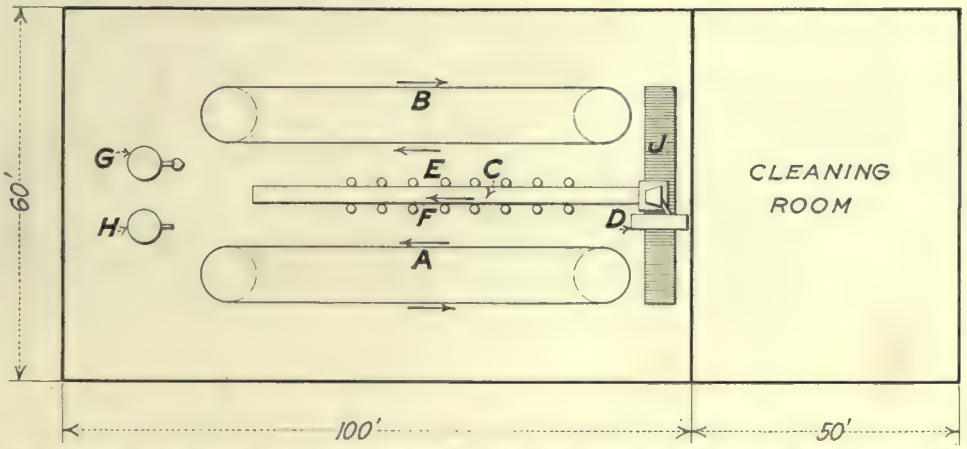

FIG. 1 FLOOR PLAN FOR FOUNDRY USING THE CONVEYOR TYPES SHOWN IN FIGS. 2 AND 3

A, B—Continuous conveyor; *C*—Scraper conveyor for distributing sand to bins; also returning superfluous sand to reclaiming machinery *D*; *E, F*—Position of molding machines under the sand conveyor; *G, H*—Cupolas; *J*—Shake-out pit.

A good example of the saving brought about by the application of this principle is afforded by the work of the molder in the modern foundry. Formerly the molder used to shovel and carry his sand, but now he simply pulls a lever and the sand is shot down into his flask from an overhead bin. He then transfers his flask from the molding machine to a conveyor. As this conveyor is supposed to be fed by the molder at regular intervals, it times his operations; a glance at it, therefore, reveals to the foreman the rate of production of the molding machines. While the flasks are in motion, cores are set, flasks are closed, and the pouring done at a point near the cupola; thus not a minute is lost. The speed of the conveyor absolutely determines the rate of production of the foundry—a rate which each individual workman is forced to maintain.

Moreover, a complete conveyor system throughout the foundry provides for the mechanical transportation of all units. This includes sand handling, sand reclaiming, transferring of cores, carrying the flasks to the cupola, thence to the shake-out pit, and finally returning them empty to the molding machines; also transporting the finished castings to the cleaning-room. Each unit of the system is timed with corresponding units to form a complete cycle, and as a result only a small amount of sand and comparatively few flasks are used.

In the case under discussion it was possible to instal a complete conveyor system, and wherever the complete conveyor system is practical it should by all means be installed, as the unvarying result is a large increase

* Mr. Macrae was graduated from McGill University in the course of mechanical engineering in 1910. He was employed by the St. Lawrence Engine Company for the next two years, and for one year by the Herschel Spillman Company. He left this position to accept the position of mechanical engineer with the Ford Motor Company, where he remained for eight years, leaving there about a year ago to join the machine and tool manufacturing firm of which he is at present chief engineer.

in production and a marked decrease in labor expense. But the complete conveyor system is not always practicable. Whether its installation will prove economical or not depends upon two factors. The first is the amount of metal poured per day. It is obvious that with the conveyor system, where flasks are brought to the cupola in regular sequence, pouring must be continuous. And to pour continuously it is necessary to use a fairly large amount of metal per hour. In the second place, it is preferable that production should consist of a fairly large number of castings which may be made in flasks of about the same size and of a similar nature—flasks which adapt themselves to the type of conveyor under consideration.

When these two conditions do not prevail, thereby rendering the installation of a continuous conveyor system impracticable, it is often found that a partial conveyor system is a profitable investment, an excellent example of this being the sand-handling conveyor. This type can be installed in almost any foundry where molding machines are used. Briefly, it operates as follows:

After the workmen empty the used sand from the flasks into the shake-out pit, a scraper conveyor and an elevator conveyor transport it to a revolving screen. Here all foreign matter is separated from the sand; after fresh sand is added, it is tempered and revivified. It is then conveyed to storage bins, where it is released into the flasks when the molder pulls the lever.

This system is set into operation as soon as the flasks are shaken out. Thus the conveyor eleminates the necessity of employing a "night-gang," whose duties are to pile up the sand, sometimes wheeling it from one end of the foundry to the other, and to prepare it for the following day. The conveyor reclaims practically all the sand previously used, and it keeps the foundry much cleaner.

Another type of the partial conveyor system elevates coke and pig iron to the charging floor of the cupola, and this type, too, can be installed to advantage in practically any foundry. An interesting application of the complete conveyor system is illustrated in Figs. 1, 2, and 3, which show the foundry of the Kelsey Wheel Company, Detroit, Michigan. This system is designed for casting tractor wheel hubs, with spokes in place. The flasks are carried from the molding machines to the cupola on a hanging type conveyor, whose track and driving mechanism are well above the floor. When suspended in this manner flasks are not liable to injury from any uneven motion of the conveyor; moreover, a greater degree of accessibility is attained for pouring, as is clearly shown in the first photograph by the position of the two workmen at the left.

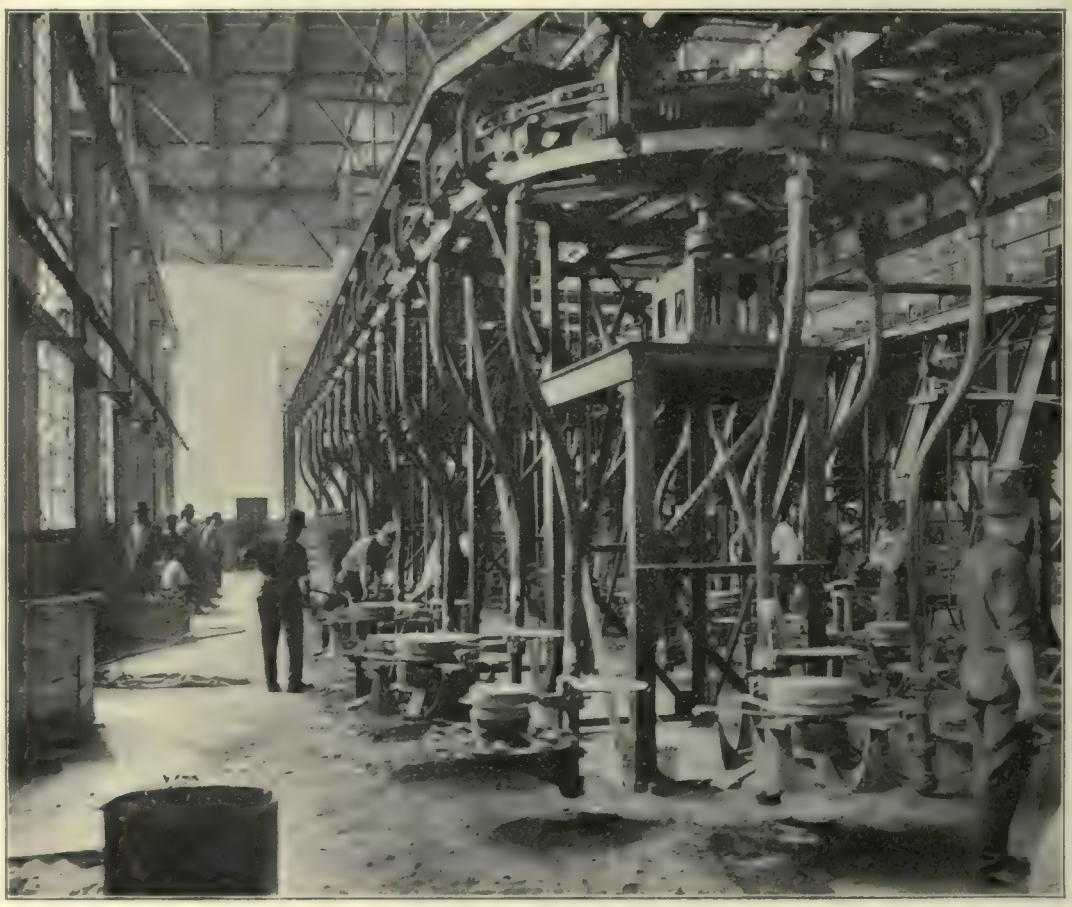

FIG. 2 CONTINUOUS CONVEYOR OF HANGING TYPE IN THE PLANT OF THE KELSEY WHEEL COMPANY, DETROIT, MICH.

This conveyor is used for casting tractor front and rear hubs, with spokes attached. This view is taken from the cupola end; workmen in the left foreground are shown pouring. Note the accessibility of the flasks. The molding machines are at the right, under the sand chutes; the conveyor travels in a clockwise direction. Shake-out pit and sand reclaiming machinery are located at the far end.

After the pouring operation flasks are carried around to the shake-out pit, which is located at the far end of the conveyor. Here each flask is lifted off by hand, shaken out, and placed on a gravity conveyor to be returned to the molding machines. Castings are moved on a mechanical conveyor to the cleaning-room, while the sand is reclaimed by means of a sand-handling conveyor of the type described above. A

floor plan of this foundry is shown in detail in Fig. 1.

Two hundred and fifty pieces, weighing on an average 55 lb., are produced hourly by this system. This means an approximate capacity of seven tons of metal per hour. To equal this production in a foundry without conveyors would require a floor space of 25,000 sq. ft. for the flasks alone. In the case described the entire foundry occupies a building only 50 by 125 ft., or 6250 sq. ft. Not only is the floor space reduced, but the number of flasks required is only 70, whereas this foundry without conveyors would require 2000. In this connection it is interesting to note that a certain large foundry company recently found that the conveyor's saving in flasks alone would pay for the installation of the entire conveyor system.

There are a number of other advantages in the complete conveyor system. For one thing it reduces the amount of sand required as much as it does the number of flasks. Moreover, the sand is of a more uniform quality, because of the reclaiming process, and the life of the flask is prolonged as it is not subject to rough usage. The handling of cores on conveyors also reduces breakage, and it permits continuous drying. Labor costs, too, are considerably lessened. Without a conveyor the total output of metal must be discharged in a short time, so a large cupola is required; with a conveyor this output is continuous throughout the day, permitting the use of a cupola of smaller proportions.

In view of all these advantages it may seem peculiar that the conveyor is not in more general use in foundries at the present day. Perhaps this is to a large extent traceable to the attitude of the foundrymen, who have been accustomed to working at piecework rates; also because the conveyor puts on a scientific basis what they call "secrets of the trade."

Precedent has led foundrymen to adopt certain methods, which they have learned through years of apprenticeship. The methods of gating and venting, for example, and the formulas for mixing sand and iron have been held as secrets. For this reason, the operation of the foundry is often dependent upon one individual, who is seldom inclined to recommend the installation of a conveyor.

Finally as a general thing, the piecework rate is abolished by the installation of the conveyor. The cost per piece can be determined with greater accuracy, however, with the conveyor; and its speed is an absolute and unfailing control of the foundry's daily output.

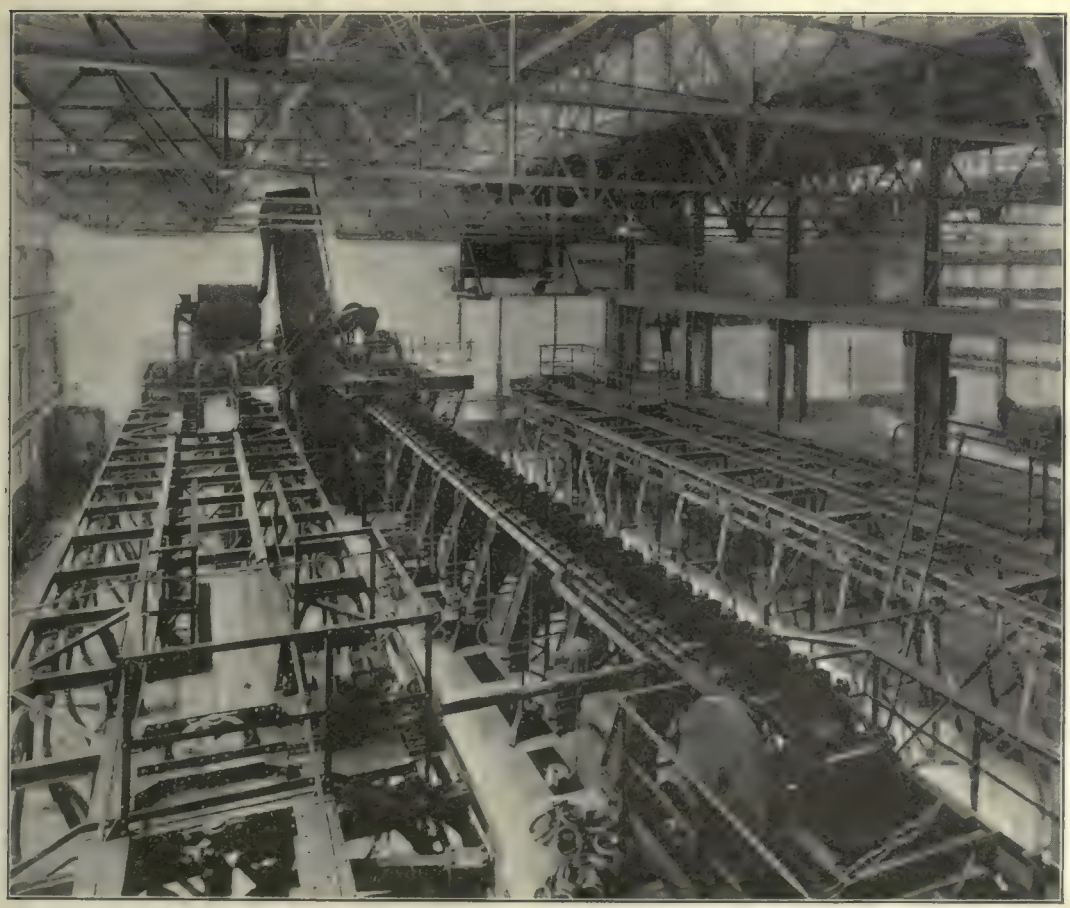

FIG. 3 LOOKING DOWN UPON THE COMPLETE CONVEYOR SYSTEM IN THE PLANT OF THE KELSEY WHEEL COMPANY

The continuous hanging type conveyor, shown in the preceding photograph, is at the extreme right and left. The scraper conveyor is shown in the center. It moves toward the observer, carrying sand from the reclaiming machinery shown in the background. Note chutes underneath this conveyor, which feed the molding machines when in place. The conveyor returns underground, taking back all superfluous sand.

Research in industrial plants *658.32*

The Administration of the Research Department

By R. W. SELLEW

Research Engineer, Fafuir Bearing Company

NEARLY all of the large manufacturing plants in this country and even many small ones carry on extensive research or experimental programs and the methods used in the administration of such research

departments are probably as numerous as the concerns running them.

There are two extremes found in the administration of research departments which, unless properly blended, are bad pitfalls. The first is that in which problems for development are instituted only in the engineering department; the second, that in which the men in the shop furnish the ideas through the mdium of "suggestions for improvement," as they are usually called. The former has the advantage of a broader knowledge as to the cost of various operations, either in point of material, labor, or scrap, which is available to the engineering department; but it has a decided disadvantage from the lack of intimacy on the part of the engineers, with shop conditions as seen by the men.

It is apparent then that the ideal condition is co-operation on the part of all departments in the instituting or suggestion of experimental problems. A slight check must be held on this system or the condition is apt to arise of all the various department heads prosecuting their own experimental work. This immediately leads to duplication of work and the overstepping of authority. For the proper administration of this branch, however, as is true of all others, there must be one man in charge of all the work.

The head of the department must of necessity be familiar with all processes and methods employed by his concern. In addition, he should keep himself well informed on the progress made by competitor companies. While this is not always possible, many helpful hints will be secured from competitors' advertisements and literature, articles in trade magazines, and papers presented before the various engineering societies. He should also be closely in touch with as many of the shop men as possible.

STUDYING RAW MATERIALS AND PROCESSES

In a large number of shops, probably nothing would be gained by changing the materials used. There are many industries, however, which are continuously developing new materials; and when either a chemical or metalurgical department exists, development of this sort will emanate there. In this event, the research department should be kept in close touch with the progress made. If the requirements placed upon the material are of a physical nature, the latter should have full authority in the matter of tests. On the other hand, the improvement may be one of heat-treatment, in which case the metalurgical department will have the authority;

The study of processes and machines will also emphasize the necessity of co-operation on the part of the shopmen. They know the manufacturing difficulties well, and while they may not be able to provide a remedy, they can certainly help in the diagnosis. As a means of locating operations needing improvement, the cost sheet will prove valuable. Here it is well to keep in mind that the operation in question may not be at fault but that the inaccuracy or lack of consistency from the preceding one may be the seat of the trouble.

An investigation of rejection causes will point directly to possible improvements. To use this means successfully, however, the engineer must be logical in his deductions or the wrong operation will be blamed. Where the finished product is susceptible to endurance tests, failures developed will prove interesting. Here again, care must be used, for unless all the conditions of the test are known, the results will be of no value.

A careful analysis of the proper operation sequence should likewise be made. One must be certain that the inaccuracies do not multiply from one step to the next. This trouble can be overcome to a great extent by finishing each part from as few reference points as possible. In this connection, the practical limits of accuracy of every machine should be known and the work tolerances kept well within these limits of performance or high rejections will result.

THE DESIGN AND MANUFACTURE OF PRODUCT

The relationship of design to the manufacturing equipment at hand has been touched upon above. It is an important subject and is worthy of the attention and combined effort of the engineering department. The practice of competitors is available for use so far as the design itself goes and whenever possible, tests of their products should be made, as these will prove of advantage as a check on one's own product.

In addition to meeting the requirements of the equipment available, the design must also meet with the approval of the trade. To do this, charges are necessary from time to time in accordance with the market. This end of the problem can logically be handled by the research department acting with the sales manager.

The relationship of the research engineer to inspection depends largely on the product and policy of the company. In the manufacture of a high-grade product governed by a rigid inspection system, many problems will arise which should be investigated by the research department.

Means of so building accuracy and fool-proof arrangements into the equipment will often result in lessening the necessary amount of inspection. This may be done by the installation of automatic gaging devices on the machines themselves, such that the work turned out can be nothing else than correct. Such an arrangement will necessitate floor inspectors to occasionally check the quality of work in order to immediately detect a failure of the automatic devices.

When sales data of a technical nature is desirable, the research department is best fitted to prepare it. The results of endurance tests, or data concerning the physical characteristics of the materials used, the accuracy of manufacture, and the advantages arising from special features of design may all be tabulated and proved by test with the equipment and facilities usual to the research department.

In conclusion, it will be fitting to again emphasize the value of co-operation between the research and all other departments, for if such a condition fails to exist there are inevitably many problems of development neglected. No department requires more patience or tact in its administration, nor can any department be of more advantage to an organization if properly managed.

The Organization of Knitting Mills

Standardizing the Physical Conditions

By CARLE M. BIGELOW*

Chief Engineer, Cooley & Marvin Company

THE previous article[1] showed how an effective type of organization for a knitting mill might be laid out and provision made for tying together the various steps of production and cost control so as to obtain a unified system. An equally important and perhaps more fundamental problem is the matter of plant layout and routing.

The average knitting plant falls into one of two general classes—the smaller plant which is usually installed in rented space or in a small building previously used for other purposes, or the plant installed in modern concrete buildings erected specifically for the purpose, such as many of the older large knitting concerns are building for practically their entire plants. It is obvious that the first class, as a rule, is merely a makeshift to meet the exigencies of a yet undeveloped business, and usually their physical conditions are far from satisfactory. On the other hand, modern buildings of the second type are wonderful examples of effectiveness and show the result of careful engineering in both their design as buildings and in their adaptation to the product and equipment.

From a management standpoint it is, of course, a splendid foundation for the efficiency of a plant if it is housed in a modern building with excellent natural and artificial illumination and the equipment laid out for maximum ease and routing. It is the purpose of this series, however, to outline the reorganization requirements of a concern not so fortunately situated. The following article, therefore, treats largely of the necessary steps to be taken in the reorganization of a plant whose buildings have not been primarily chosen for the industry or where engineering has not been employed to lay out the equipment scientifically.

The first requirement in making a study of the necessity for re-routing is to obtain from the local management an analysis, if there is a large variation in classes of product, of those units which are handled in the largest quantities and their relative operational sequence; or in case a general constant product such as silk hosiery is manufactured, the sequence of operations alone need be determined.

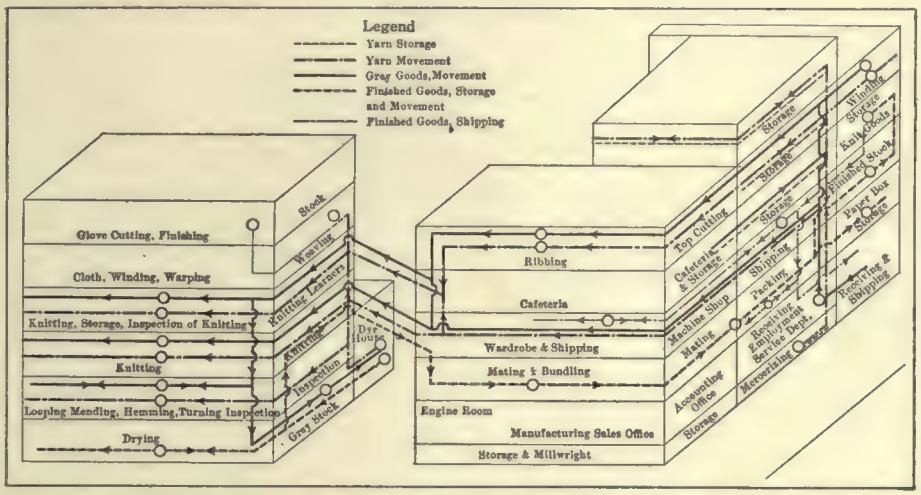

FIG. 5 A STUDY OF ROUTING FROM THE ENTIRE PLANT VIEWPOINT

Next the major operations should be charted as shown in Fig. 5. Such a study will indicate whether the flow of material and product throughout the plant is generally systematic or not, and also whether the rerouting must be considered in terms of the plant as a whole or according to individual departments.

CASE 1. WHERE ROUTING IS A PLANT PROBLEM

When the general movement chart as shown in Fig. 5 shows a lack of systematic progress of the material and product throughout the plant, a study of the plant as a whole should be made with a view towards evolving a general plan of routing. The charting of such a study is shown in Figs. 6 and 7. Fig. 6 shows the general routing of a product in the original plant and Fig. 7 the proposed general routing for the entire plant, bringing into consideration the ultimate expansion of the plant in terms of the new buildings required.

In all routing problems in the knitting industry it is essential to give unusual consideration to illuminating requirements. As shown in Fig. 7 illumination for the various operations of the plan is divided into three

* Mr. Bigelow was graduated as Bachelor of Science in chemical engineering from the Rhode Island State College, and during the present year has had conferred upon him the professional degree of mechanical engineer by the same institution. His experience in industry began as an operative in all the departments of cotton manufacturing and dyeing—with the Manville Company. From October, 1912, to June, 1916, he was operative, gang boss, foreman, time-study man, engineer and plant superintendent for the Glenlyon Dye Works. From that time until June, 1918, he was senior engineer for the Cooley & Marvin Company, and on the latter date became the chief engineer of the firm.

[1] See MANAGEMENT ENGINEERING for October, 1921, p. 193.

classes, namely, primary visibility for departments such as winding, knitting, cutting, inspecting, clerical work, and machine shop; secondary visibility for the various preparatory processes and the carding and spinning of yarn; and a third class of visibility, largely used for packing, storing, and similar operational phases where excellent illumination is not so essential.

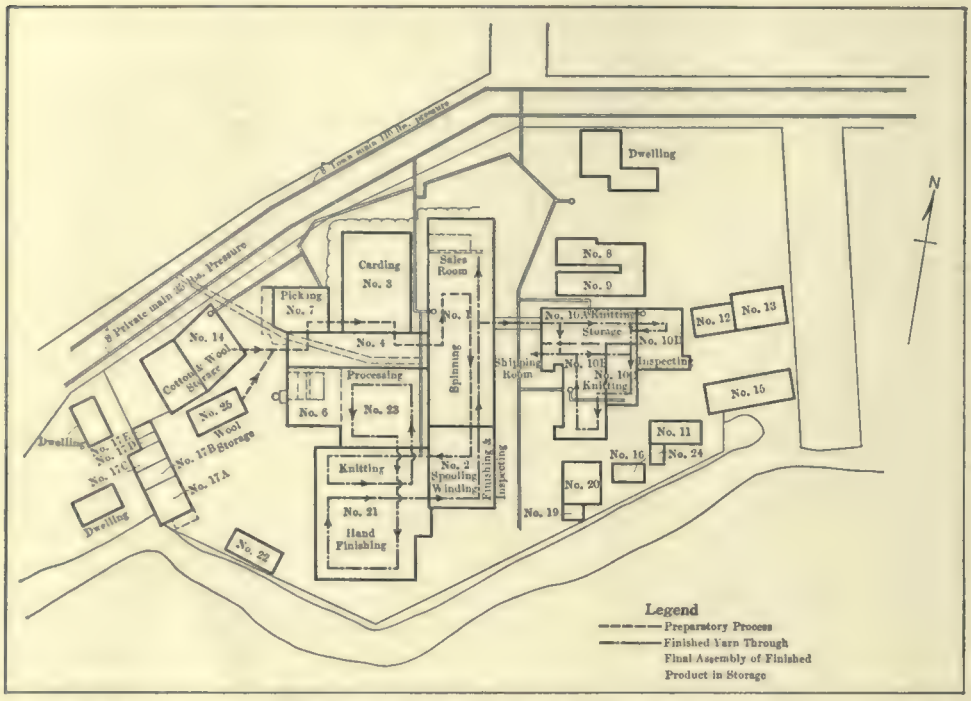

FIG. 6 A TYPICAL LAYOUT OF A MILL WHICH HAS DEVELOPED WITHOUT A LOGICAL PLAN

CASE 2. WHERE GENERAL ROUTING IS FOUND SATISFACTORY BUT DEPARTMENTAL ROUTING CAN BE IMPROVED.

Where departmental routing must be considered, the present routing is first charted up as shown in Fig. 8, charting the routing of the principal products, and finally a revised plan is made, such as shown in Fig. 9. The making of routing charts for the individual departments can be most simply accomplished by the use of templet drawings.

Templet Drawings. Templet drawings consist of scaled outline drawings of each floor of each building on which are noted all such permanent equipment as elevators, stairways, etc. Thin cardboard, scaled cutouts should be made, using the same scale as the floor plans and showing the actual overall dimensions of every article of equipment, such as machines, benches, racks, etc. In the case of machines a red arrow should indicate the direction of flow or product through the machine and a green arrow the direction of application of power. A small red cross should be placed on the side of the machine or bench at the point where the operator stands and a small red circle at each point where a helper stands. This allows the units of equipment to be placed upon the scaled drawing and moved about until a satisfactory arrangement is found, the various symbols on the machines allowing the equipment to be set in its proper relation to supply of product, power, illumination, etc.

In making such a layout, however, besides the more even and direct flow of the

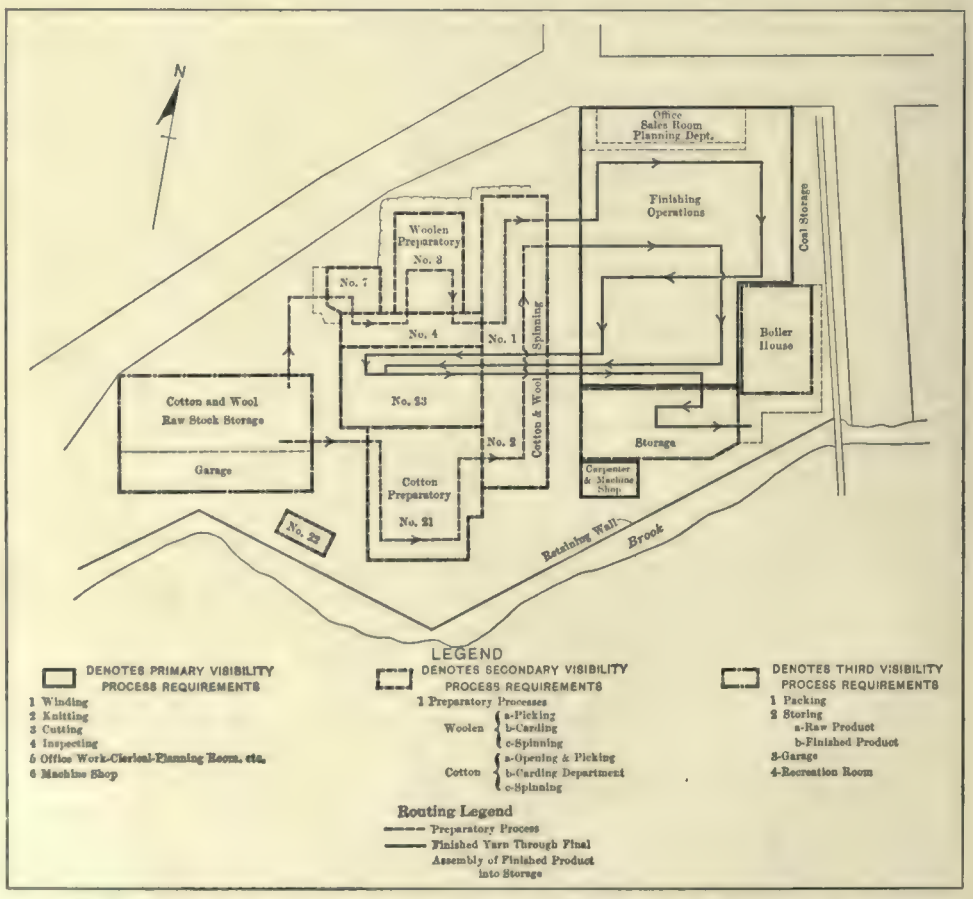

FIG. 7 A REVISION OF THE PLANT SHOWN IN FIG. 6 REQUIRED FOR ECONOMICAL PRODUCTION

product there are certain other points of prime importance that must be considered.

Illumination. One such point, as has been stated above, is illumination. In Fig. 10 is shown a study of the layout of looping machines in a hosiery plant according to the illumination requirements, and every knitter realizes that the illumination requirements for this operation are extremely severe. The left side of the figure shows the original arrangement of machines, the shaded section representing the portion of the room not receiving the requisite amount of daylight for the looping operation. At the right of the figure a rearrangement of the machines is shown whereby the machines are all placed within the area of prime visibility, the supply of product, where light is least essential, being located in the darkest area of the room.

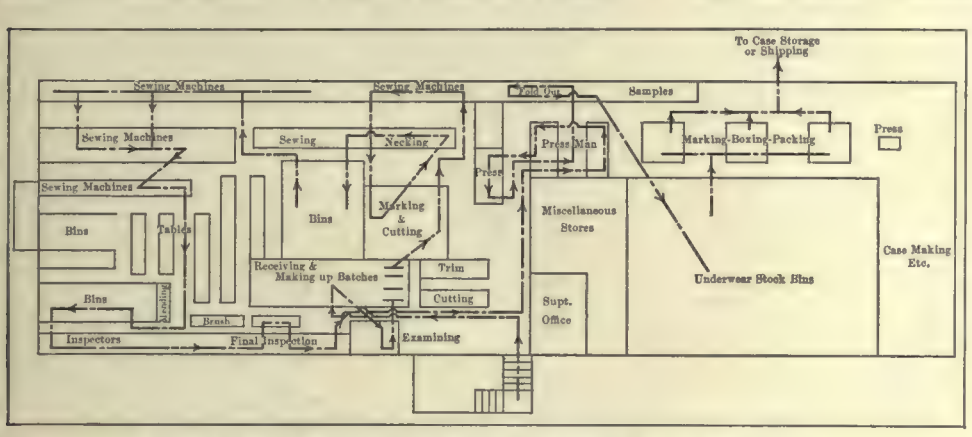

FIG. 8 PLAN SHOWING DEPARTMENT LAYOUT BEFORE REVISION

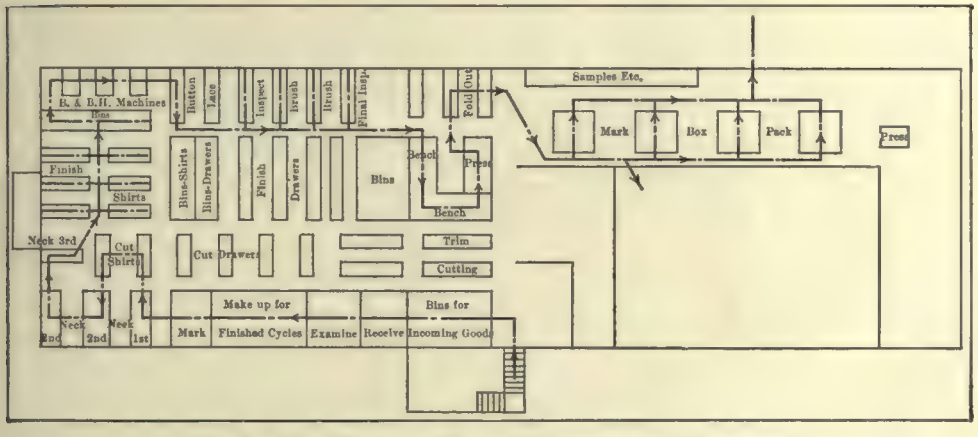

FIG. 9 PLAN SHOWING REVISED DEPARTMENTAL ROUTING

Manufacturing Efficiency. Manufacturing efficiency must also be considered. In Fig. 11 a layout of knitting machines is shown where a fundamental plan of machine layout was made so as to provide for a careful inspection of the product of the machines. These machines are shown in the upper right-hand corner of the layout, and it will be noted that at each end of each double row of machines a rectangular space is indicated for an inspector's bench. This arrangement is for the purpose of allowing an inspector to follow closely the production of the 25 machines nearest to her on both sides of an aisle in the direction indicated by the arrows. In this particular case such an arrangement was necessary owing to the fact that a product was made using an extremely expensive yarn and that there was practically no market for seconds. It was found that the cause of seconds was largely due to machine trouble, and by having each stocking as it was produced hung on a wire at the right of the machine the inspector was required to inspect practically each stocking as rapidly as it was turned out. If any fault was found she immediately hung the faulty stocking on a lower wire, stopping the machine instantly; thus the possibility of machine trouble continuing for a long period was prevented. Before this layout and method of inspection were devised, sometimes a machine went on producing faulty goods for several hours before the fact was noted. This example illustrates the consideration which must be given in departmental layouts to actual manufacturing requirements.

Internal Transportation. The transportation of material and product is another matter requiring careful attention. After a tentative arrangement of the equipment has been devised, the engineer should study the transportation of product throughout the factory, considering the various devices or transporters to be used and specifying or designing wherever possible automatic conveyors, slides, chutes, etc., to transport the product mechanically. In this connection standard equipment should be specified wherever possible, as especially designed equipment is

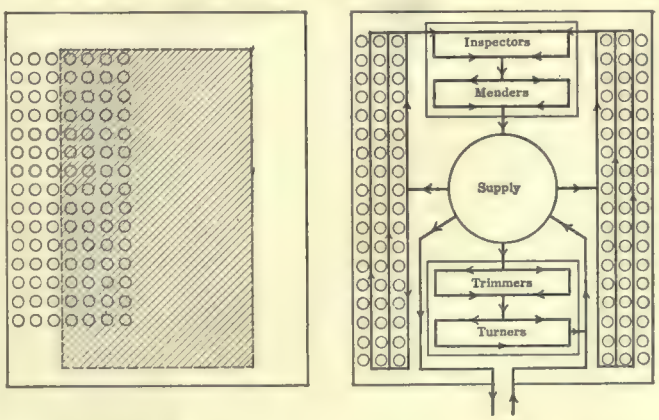

FIG. 10 ORIGINAL (A) AND REVISED (B) LAYOUT OF A DEPARTMENT TO IMPROVE UTILIZATION OF NATURAL ILLUMINATION

expensive and difficult to obtain. However, if it is possible to obtain a marked increase in manufacturing efficiency by using some special design, this should be provided. With reference to the use of trucks about a plant, consideration should be given to the special requirements of the different departments. Only too often one or two types of trucks are manufactured and used universally throughout a plant, and while this is a reduction of the first investment, rarely will such a standard truck satisfactorily meet manufacturing needs throughout the entire plant.

Aisles and passageways should be carefully studied in order that congestion will not occur in such transport areas and space not wasted where the traffic requirements are slight. Consideration should also be given to the necessity for accumulation spaces between operations of varying speeds. For instance, behind a very slow operation, unless its slowness can be overcome by increased effectiveness, accumulation space must be provided. Accumulation spaces must also be provided at points where several units of product come together for joint operation.

Standardization. At the same time that the physical rearrangement of the plant is being worked out, motion and time study and investigation of the effectiveness of the individual processes should be carried on. This is necessary because before any final layout of the factory can be approved the relations of each process must be studied as noted above, and it must also be ascertained whether the best equipment obtainable has been provided for each operation.

Consultation. As the templet plans approach completion and the investigation of shop practice and effectiveness is well under way, frequent consultation should be held with the management, the shop foremen and forewomen, and in some cases with expert workers, regarding the relation between various operations and the arrangement of individual machines, or groups of machines, and equipment.

Engineering Consideration. When it has been agreed that an effective operating layout has been created, the layout should next be criticized from an engineering standpoint. Are the buildings sufficiently strong at all points for the continuous operation of the equipment, storage of the necessary weight of stock, etc.? Is illumination by daylight satisfactory or should certain continuous artificial illuminations be provided? Is it possible to apply the power load economically? All such questions which arise in a plant when considered from a strictly mechanical aspect should be taken up, and any differences between mechanical efficiency and operating effectiveness should be studied and the more important needs satisfied in each case. In this way the final result will be the best mechanical and most effective manufacturing layout possible to develop in the minds of the organizer and the management, it being always borne in mind, of course, that the investment to bring about such reorganization must be kept within

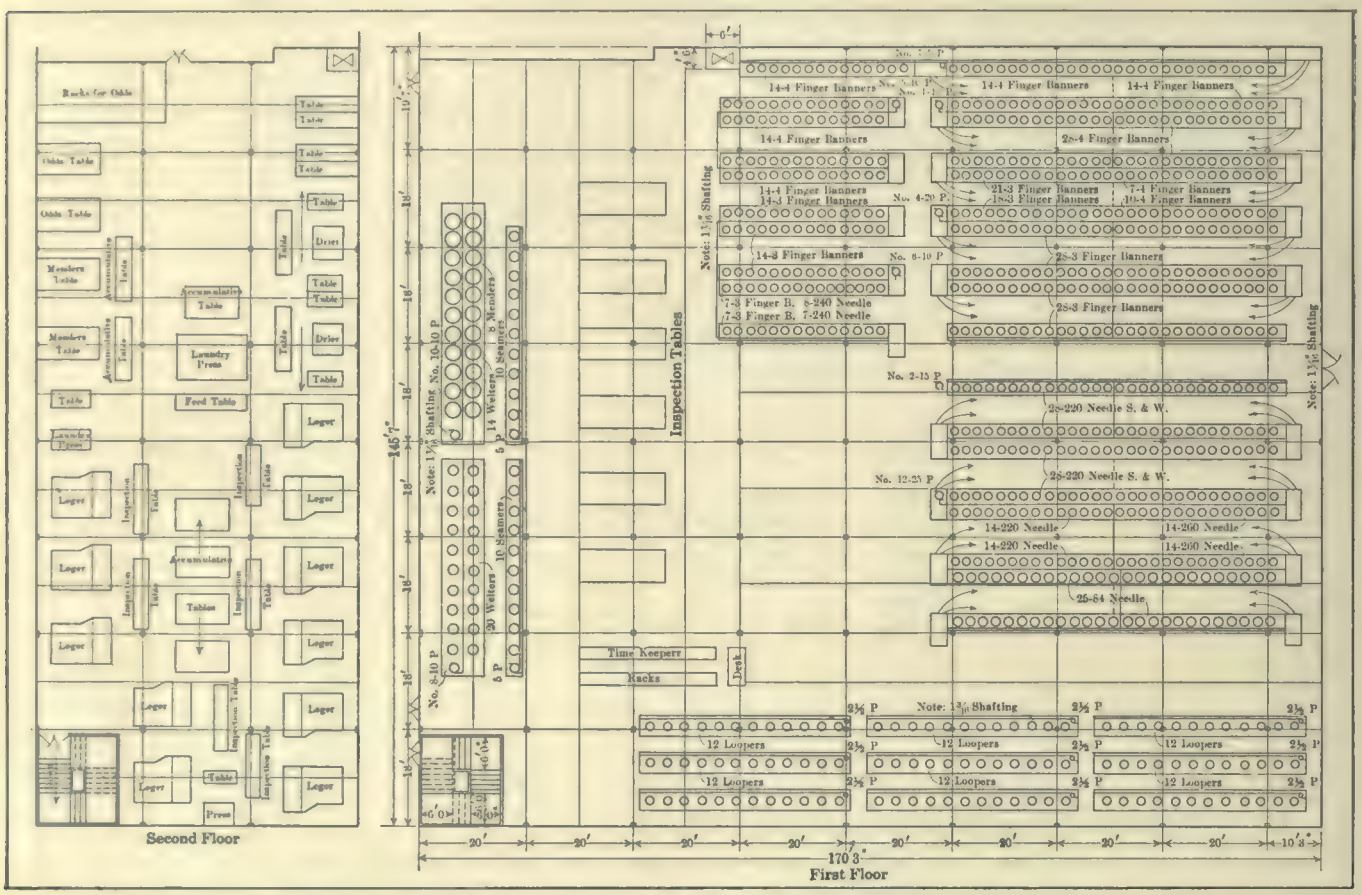

FIG. 11 A DEPARTMENTAL LAYOUT BASED UPON INSPECTION REQUIREMENTS

the capital investment possibilities of the business.

Plant Model. When all rearrangements considered necessary have been worked out on the templets, a model of the plant may be built with small, scaled blocks and sheets of wood, representing the relation of the various buildings, floors, and equipment. The principal units of product should then be traced through this model by means of colored strings, and any relation found unsatisfactory should be rectified. After the approval of such a model it can well be assumed that the problem has been given sufficient study, and the final drawings can be safely prepared.

THE ACTUAL PHYSICAL REARRANGEMENT

After the proposed rearrangement has been entirely worked out and detailed plans prepared, the reorganizing engineer should carefully schedule the actual carrying out of the reorganization. For instance, if much machine movement is required, location space symbols should be worked up and a symbol assigned in advance to the location to which each machine is to be moved. It is also advisable to outline definitely the exact order in which changes are to be made and to provide a progress chart, so that the carrying out of the schedules may be carefully checked. A simple but effective progress chart may be made by taking a blueprint of the proposed rearrangement, and as each item is placed in its correct location outlining this item on the print with a red pencil. Reference to the schedule and to this print will show exactly how the schedule is being executed.

The following is an actual example of such a schedule for moving an office and storeroom. For machine departments each machine should be listed by number.

1. Clear Basement No. 8 Building: Oct. 30-Nov. 5.

The space to be cleared is used for yarn, thread, wrapping paper, pipe, hardware, and miscellaneous stores; a great part of which is a result of vacating Jones's warehouse. It would appear advisable to re-lease this warehouse for a limited period, which we understand is possible, and use the space to store the material now in the basement of No. 8 building which cannot be disposed of otherwise. Surplus yarn, thread, etc., also the 8 sections of steel stores racks, representing the reduction in stores, could be stored in this warehouse.

2. Relocation of Dry-Room, Basement No. 3 Building: Nov. 7-8.

Relocate dry-room on opposite side of stair tower.

3. Plumbing, Electrical, and Paint Shop, Basement No. 3 Building: Nov. 9-12.

Consolidate these shops into space now occupied by the plumbing and electrical shop.

4. Stock, First Floor No. 3 Building: Nov. 14-19.

Relocate wood stock racks in south end of basement of same building.

5. Steel Stores, First Floor No. 3 Building: Nov. 21-Dec. 3.

Remove steel stores shelves and racks from first floor, cut down and re-instal 21 sections in basement of No. 8 building. It is suggested that the dismantling of steel shelving be done in groups of 7 sections, to interfere as little as possible with stores distribution. The steel uprights are to be cut by acetylene torch or band saw to approximately 6 ft. in height, straddling drilled holes to permit direct reassembly, making two sections out of each present section. The present wire fence with gates and wickets to be cut down or refabricated to suit basement head room of 6½ ft.

6. Partitions, First Floor Building No. 8: Dec. 5-6.

Remove portions of office partitions on this floor where indicated on plans.

7. Painting, First Floor Building No. 8: Dec. 7-8.

Paint walls of office space white and light gray to aid natural illumination.

8. Additions to Toilets: Oct. 30-Nov. 12.

Instal additions to first and second floor Factory A office toilets.

9. Moving Planning and General Office: Dec. 10-12.

Move planning and general office into new quarters on first floor of building No. 8 over a week-end simultaneously with changing switchboard and telephones and auto-call. Locate design department temporarily in space on second floor now used by allocation clerks.

10. Industrial Relations and Employment: Nov. 14-19.

Move industrial relations and employment divisions to present Factory A, first floor office.

11. First Aid Division: Nov. 14-19.

Relocate on second floor, Factory A office, including necessary partitions, lavatory and toilet.

12. Office Lighting: Dec. 1-10.

Extend lighting circuits where necessary for proper illumination. The fixtures required to be taken from the present general office installation.

Management engineering. Supervision *658.372*

A Comparison of Supervision Charges

By C. L. WHITE

With the A. D. Cutting Body Corporation

IN expanding an organization to the extent where additional supervision is required what is the proper procedure to follow? To open the discussion, let us consider a part of an organization having a general foreman, three foremen, and 18 productive workmen under the direction of each of the latter. (See Fig. 1.)

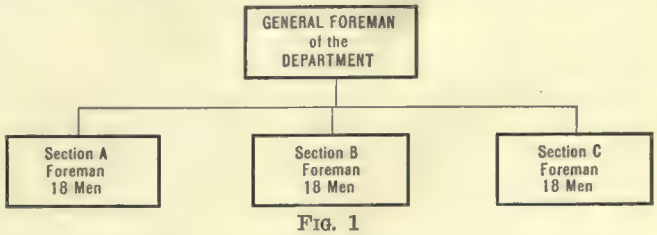

FIG. 1

We will further assume that the number of workmen per foreman is about the maximum allowable for the trades involved, if the highest degree of supervision is to result in the best production and the desired standard of quality of the product. A further necessary assumption is that the weekly pay-roll for supervision of this group is as follows:

General Foreman	$ 60
Foremen (3 at $50)	150
	$210

Due to increase in orders 12 workmen are added to

the department and are placed in section C. As a result of the expansion of this section the foreman picks two good men and promotes them to sub-foremen at $45 per week and divides the 30 workmen between them, making 15 workmen for each sub-foreman. The organization then becomes as shown in Fig. 2.

This change has now increased the weekly pay-roll for supervision as follows:

Previous weekly pay-roll for supervision (Fig. 1)	$210
2 sub-foremen added at $45 (Fig. 2, section C)	90
	$300

We will now suppose that the general foreman expands his organization by selecting another foreman and establishing another section (section D) and thus

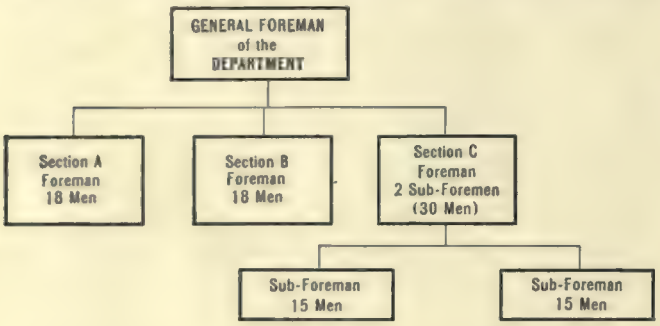

FIG. 2

developing his organization as shown by Fig. 3. It will be noted that section C has been slightly decreased to equalize sections C and D. The weekly pay-roll for supervision of this organization now becomes:

General Foreman	$ 60
Foremen (4 at $50)	200
	$260

Thus a saving of $40 per week has been effected in an organization numbering 5 executives and 66 workmen.

Other than financial advantages of this organization (Fig. 3) are:

1. The general foreman is nearer the workmen of sections C and D (Fig. 3) than he is to the equivalent sections of Fig. 2, resulting in:
   (*a*) The channel for orders being shortened.
   (*b*) Supervision of workmen vested in a higher paid executive.
2. Adustments of difficulties between sections made easier because of:
   (*a*) Less number of executives needing to be conferred with to secure co-ordination.
   (*b*) Better "executive balance." In Fig. 2, section C, has three executives as against one each for A and B.
3. Less difficulty in co-ordination of the foremen, due to more even distribution of workmen.
4. No argument as to increasing wages of the foreman of section C, which would be the case under Fig. 2.

If we assume that the average wage paid the workmen is $40 per week, the conditions which will prevail in the three organizations given will be as follows:

Fig. 1. Organization

Supervision weekly pay-roll	$ 210
Workmen (54 at $40)	2,160
	$2,370
Percentage of supervision expense	8.9
Percentage of productive expense	91.1

Fig. 2. Organization

Supervision weekly pay-roll	$ 300
Workmen (66 at $40)	2,640
	$2,940
Percentage of supervision expense	10.2
Percentage of productive expense	89.8

Fig. 3. Organization

Supervision weekly pay-roll	$ 260
Workmen (same as Fig. 2)	2,640
	$2,900
Percentage of supervision expense	9.0
Percentage of productive expense	91.0

A case may arise where the foreman of the section has such specialized ability that it is desirable to have him maintain direct supervision of the similar kind of specialized work of the additional workmen. In this case it is simply necessary to maintain the organization with

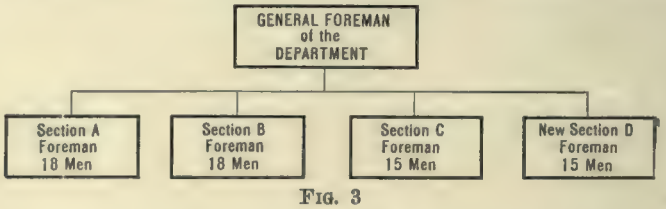

FIG. 3

only one sub-foreman, or it may be decided that this special case warrants the additional supervision expense of two sub-foremen.

In expanding an organization to the extent where additional supervision is required it would appear advisable to proceed as follows:

1. Until the *additional* help exceeds in number one-half the maximum desirable to place under the supervision of one man, place this help under the direction of *one* sub-foreman ("straw boss") with the foreman supervising his own group of workmen plus this sub-foreman.
2. When the additional help exceeds the foregoing maximum, create a new section with a properly qualified foreman named to direct them. The sub-foreman may have been promoted to the position, or maintained as a set-up man, or placed in productive work.

Finally, before accepting any method for expanding the organization, compare "before" and "after" supervision expense in the light of all factors.

Making the Truck an Asset in Management

How Special Types May Be Used to Save Floor Space, Provide Effective Storage and Minimize Moving Time Between Operations

By EDWARD H. TINGLEY*

Research Engineer, Delco-Light Company

THE improper use of floor space is just as expensive as wasted time in production and frequently it is the direct cause of much of the overhead costs of a manufacturing plant. Wasted time in production, when analyzed, turns out to be the time lost between operations due entirely to the factory system of transporting and handling the material being worked upon. We make time studies of the operator to determine to the second the time to be allowed for the machining processes, and then allow hours or a whole day for trucking to the next operation. Again, when the operator finishes his work he turns in a time ticket for the amount of direct labor to be charged against the product, but the cost of overhead adds up night and day as long as the material is in the factory, and for this no time ticket is provided. The sooner, therefore, that the parts being made are completed and assembled into the final product ready for sale, the more frequent will be the rate of turnover of invested capital and the less the cost of overhead.

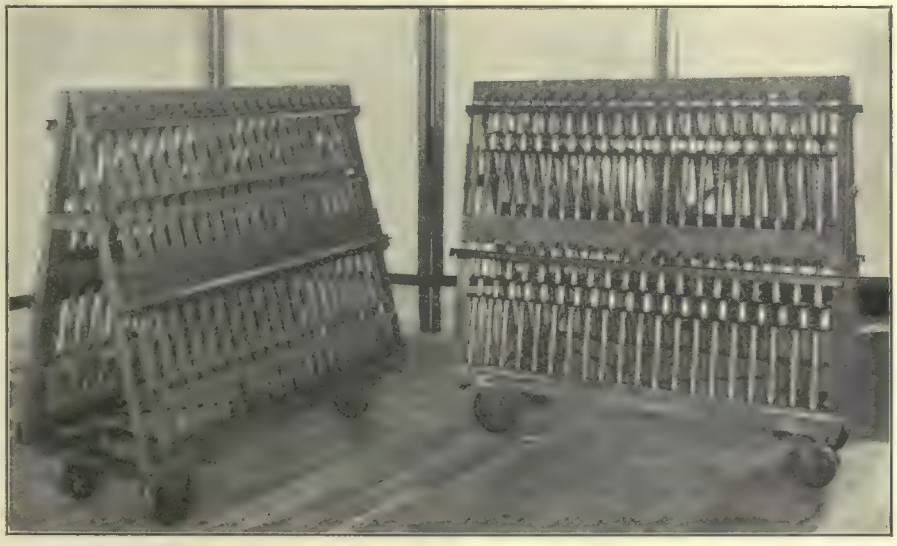

FIG. 1 FROM FORGING TO FINISHED CRANKSHAFT

The same truck is used to carry the crankshaft through all its operations from the raw stock room to the finished parts stock and even to final assembly.

Any thoughtful executive will thus see that he ought to make a time study of his methods and facilities for handling material to determine if the time between raw and finished stock cannot be shortened, thereby reducing the overhead charges and freeing capital now invested in too large an inventory. The ideal, of course, is to secure a minimum of time between the start and finish of a piece of work, and in many instances this is rendered possible by arranging the machinery in positions for progressive manufacture. Many operations, however, are not done entirely by machines, but are of such a nature that they must be done in a separate department or building, as, for example, enameling, heat treating, plating, sand blasting, etc. These require trucking between operations, and thought should therefore be given to the problem of material handling as a whole so as to make it as efficient as the machinery and the operators.

Any device or method of handling material should do more than merely transport stock from place to place. The method adopted should be well thought out and should serve every possible phase of production. Then, instead of the transportation of stock being a necessary evil it would be a positive asset to plant management. To achieve this end the existing system in a factory should be analyzed in the light of the following ideals which should govern the designing of the conveyors, receptacles, trucks, platforms, boxes, etc., by means of which the material is to be handled:

1. The economic use of floor space.
2. Minimum handling.
3. Most efficient amount to be placed on trucks or in boxes.
4. Speed and safety in transportation.
5. Flexibility.
6. Speeding up the work of operators, inspectors, and storekeepers.
7. Permanence.

* Mr. Tingley spent the first three years after graduation from Cornell University in the apprenticeship course in the Westinghouse Electric and Manufacturing Company. He then became assistant superintendent in charge of design and production for the F. M. Burton Company, returning to the Westinghouse Company on the erection of a hydro-electric power plant in the Adirondack Mountains. Following the completion of that work until the outbreak of the war he pursued post-graduate studies at Columbia University, thence going to Washington and engaging in the production and design of gun carriages in the Ordnance Department. For the past two years he has been at the Delco-Light Company in charge of the plant layout department, analyzing the equipment and production control.

Before these ideals can be applied, however, the layout of the factory departments and buildings and the simplicity or complexity of operations must be considered. If the operations are all machine work, the machinery can be arranged consecutively for progressive manufacture, using a roller or belt conveyor between machines or movable trucks to be pushed by one operator to the next. If the operations are mixed, the machine work may be progressive and the other operations will have to be done in several distinct departments, thus making the use of a conveyor impracticable. If the factory buildings are scattered and of different heights, the transportation problem is still further complicated. In almost every factory, however, there is need for boxes, trucks, platforms, etc., and this article therefore will be limited to a discussion of such types of carriers, omitting any reference to conveyors.

1. The Economic Use of Floor Space. The saving of floor space by means of standard material containers will, of course, permit the use of more machines in a given space than if no standard method was used. By carefully considering the space the operator requires and the size of truck on which the material is piled, the space between machines can be accurately determined. Aisle space between rows of machines should be kept small, and the total space around a machine should be restricted so that work will have to be moved out of the way to make room for more. This assists in getting material promptly moved to the next operator and reduces the lost time between operations.

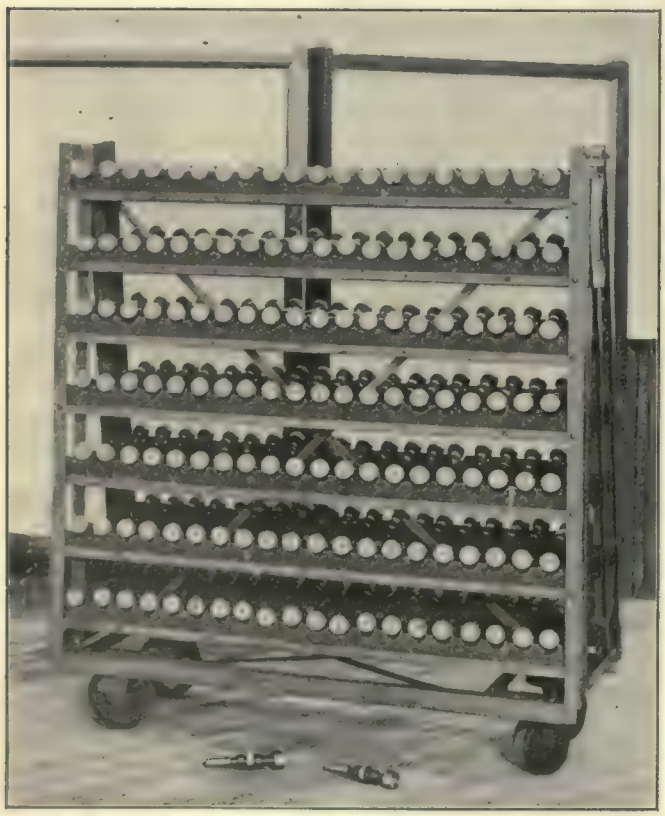

FIG. 2 TRUCK WITH WOODEN SUPPORTS TO HOLD CAMSHAFTS

One end of the camshaft slips in a hole in the wooden strip, thereby preventing it from falling off during movement of the truck around the factory.

In progressive manufacture, trucks such as shown in Figs. 1, 2, 3, and 5, which can be pushed from one machine to the next by the operators themselves, are useful, as they can be placed between two machines and both operators can work from them. If the material is

FIG. 3 STEEL TRUCK WITH SHELVES TO HANDLE THE SMALL CYLINDER HEADS

This truck will hold about 125 pieces and can easily be moved about the plant by one man.

piled on shelves as in Figs. 1, 2, and 3, more pieces per square foot of floor space can be accommodated, and the work also made easier for the operator to reach and replace, as he will then not have to stoop to the floor. There will likewise be less chance for damage if the operator can replace the work in a separate space and not drop it carelessly in a box on the floor.

2. Minimum Handling. By the use of such trucks or platforms as are illustrated in Figs. 1, 2, 3, 5, and 6, the finished material can be stored in the stockrooms on the same trucks or platforms which are used to move it through the manufacturing departments. The same truck can also be sent to the final assembly department, thus eliminating any rehandling whatsoever. Minimum handling will always reduce the possibilities of damage to the finished parts, and if this feature is combined with that of separate compartments, spaces, etc., on the truck, scrap losses from damage in handling are kept practically zero.

3. The Most Efficient Amount to Be Placed on a Truck or in a Box. The factor of minimum handling for the type of box shown in Fig. 9 is governed by what one man can lift (which is approximately 100 lb. with 125 lb. as maximum) for time will be lost if the depart-

mental trucker or machine operator must wait for assistance to move material over short distances. The capacity of the wooden box shown in Fig. 8 is determined by the size of the article or the type of material to be put in it, and when such boxes are used two men

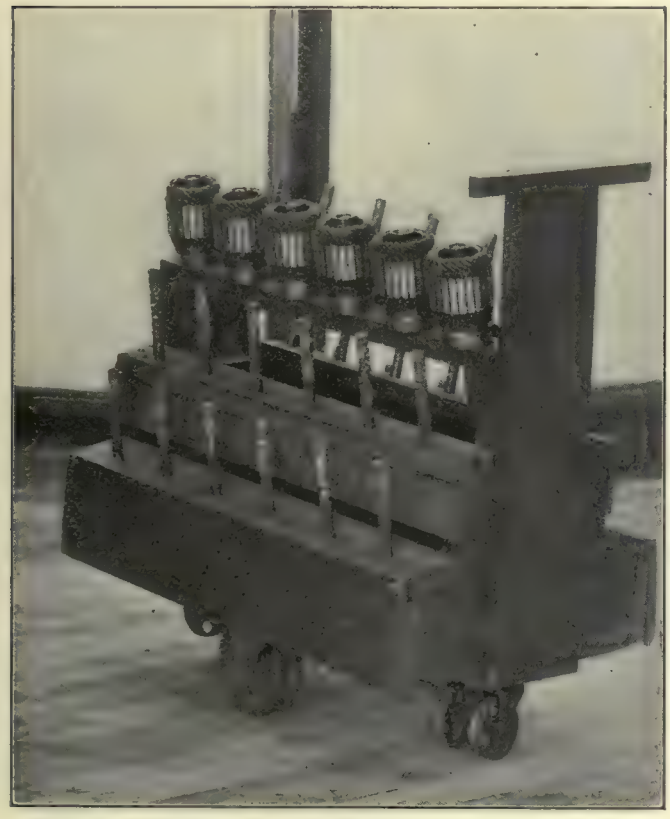

FIG. 4 A WOOD FRAME TRUCK

This type is used in the armature department for handling the armatures when complete.

are frequently required to load them on platforms or electric trucks for the longer hauls. The capacity of platforms of the type shown in Fig. 7 is measured by the size of parts and the ability of a man to handle the load with the customary type of lift truck. The lift truck has a capacity of 2000 to 4000 lb., but in a large number of factories the maximum figure is seldom handled as the size of parts, and their shape would make too large a load from the standpoint of cubic capacity. The average platform is about 30 in. by 48 in., and considering the floor conditions, and the distance of the haul, one man should not be expected to handle over 2500 lb. Heavier loads can, of course, be handled by two men, but if the stock is piled over 4 ft. above the floor there is a tendency for the load to become top heavy and upset, especially on the turn.

The amount of material that can be placed on special trucks of the type illustrated by Figs. 1, 2, 3, and 5, is dependent upon the size and shape of parts, the economical use of floor space, and the weight an average man can push over the factory floors. This last factor is an important one, for in any wheeled vehicle used in factory transportation the frictional load when in motion over the floor is a measure of what one man can be expected to push for short distances, as between machines or around the storeroom. This weight will vary considerably with the type of floor, but in the average factory using concrete, wood or composition for floors, 2500 to 3000 lb. is enough for one man to handle efficiently. For larger hauls the electric "mule" (Fig. 6) is most economical with respect to time and labor.

4. *Speed and Safety in Transportation.* These two factors are closely related, for while the aim is to reduce the time between operations by quickly moving the stock from place to place, if, in the haste of so doing, damage results, pieces fall to the floor, etc., then the final result is waste. Safety features, however, can be embodied in the design of the vehicle, as shown in Figs. 1, 2, and 5, so as to allow increased speed and prevent one piece from damaging another. The angle iron placed across the row of crankshafts, as shown in Fig. 1, for example, is hooked over cleats on the end of the frames and is easily removed when necessary. The truck used for moving camshafts (Fig. 2) relies upon the holes in the wooden members to keep the parts separate and in place, and similarly (Fig. 5) the holes in the wood frame, assisted by gravity, prevent connecting rods from dropping.

The relative merits of hand trucking and electric haulage are beyond the scope of this article, but the executive responsible for the handling of material should carefully weigh the labor cost of hand work against the capacity and speed of the electric "mules," and decide for that system which will produce the best results under the conditions existing in his factory.

FIG. 5 AN "A" FRAME WOOD TRUCK FOR CONNECTING RODS

The rough forging is placed in the truck in the raw stock room and the finished rod is taken off in the finished stock room.

5. Flexibility. In the selection and design of certain containers, such as are illustrated by Figs. 9 and 10, flexibility is an important consideration. The boxes illustrated are made in various sizes to accommodate the required amount of parts to be operated in one lot and at the same time have no excess space. Bulky sheet steel parts are piled in the large wood boxes, while heavy small parts are placed in the small steel "tote" boxes. It is not advisable to have partitions or spindles placed permanently in such boxes, as these restrict their use. Fig 9 shows a box used for small gears, which is a standard steel box fitted with a removable plate containing a number of spindles. In many designs, however, specialization should be the rule, the extent of this, of course, depending upon the quantity of any one type of part. Fig. 1, for example, is an "A" shaped truck used only for crankshafts, moving them from raw stock to final assembly departments. Fig. 2 shows another type of special truck for camshafts.

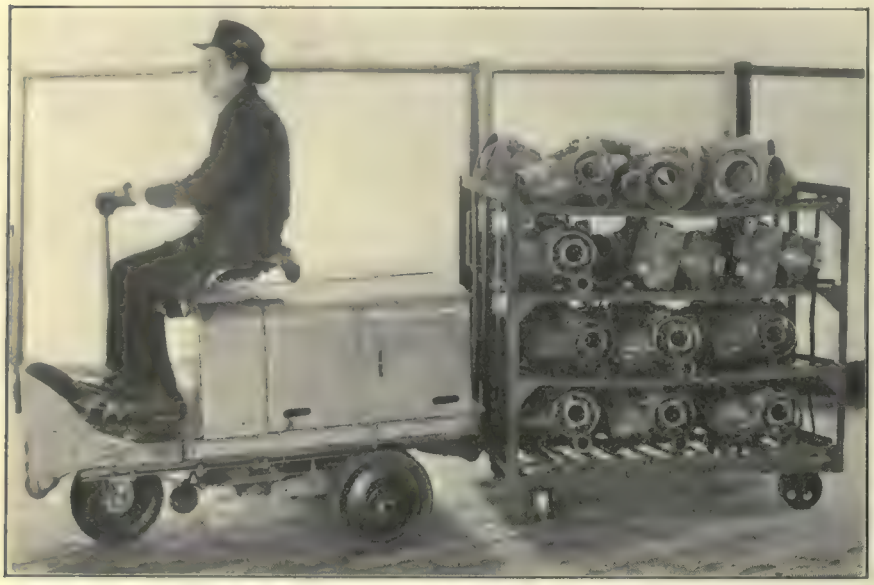

FIG. 6 A STEEL TRUCK WITH AN ELECTRIC "MULE"

The steel truck holds the heavier castings, and due to their weight and the desire for quick transportation, the electric "mule" is used to move the truck around the factory. The electric "mule" is used for all long hauls.

6. Speeding Up the Work of Operators, Inspector, and Storekeeper. The workman expects any system for handling material to help him increase his productive capacity as well as decrease his effort. The special trucks illustrated have these advantages, as they occupy a minimum of floor space and allow the work to be brought as close as possible to the machine. The trucks are easily moved by one man, and with work stacked on both sides they can be turned around to bring the other side to the machine, thus eliminating useless walking. The construction of the truck insures the separation of the pieces and so prevents damage to any finished or ground surfaces. It also suggests the idea of order and care to the workman, and it gives him the satisfaction of seeing his work progress. He unconsciously sets a goal for himself, endeavoring to complete a row or truck by noon or night. The amount on the truck is proportioned to what one man can push around and what will make a good quantity for piecework operations.

The work of the inspector should be as limited as possible, as his work is indirect labor, an item of overhead expense. In any well-regulated factory the foreman should be fully responsible for the quality of the work produced, and the inspector should merely check the foreman. If the truck, box, or rack in which the material is handled will permit of quick and accurate counting by the inspector, easy removal and quick replacement after inspection, the time of the inspector can be reduced to the minimum. Through the use of trucks such as shown by the illustrations in this article, counting is unnecessary, as the inspector knows from the Production Order card the total number the truck or box should contain, and only has to subtract the missing pieces from this total. This counting of the missing parts can be done at a glance.

The finished parts stockroom is also benefited in several ways by the special trucks, as the counting of material as received is expedited and a visual inspection can be made in a short time. If the material is to be

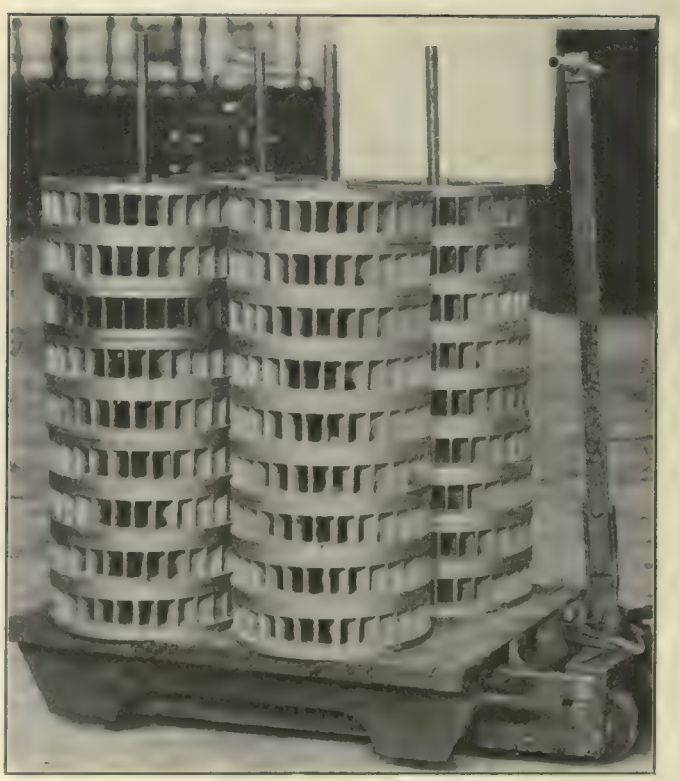

FIG. 7 A WOODEN PLATFORM LOADED WITH HEAVY FLYWHEELS

A load like this can be hauled by two men, but the electric "mule" will do the job faster and safer, for one man can ride on the platform and hold the load from shifting.

stocked in bins, the truck can be pushed to the location and emptied as desired. Frequently the material is to be used in other assembly operations, and if allowed to remain on the truck it can be sent at once without further work to the assembly department. In preparing material for group assemblies the special trucks can be loaded in the finished parts stockroom with speed and the assurance that no damage will result while in transit, and that the count is correct as to the number of pieces sent out.

FIG. 8 LARGE WOOD BOX FOR BULKY PUNCH PRESS PARTS

These boxes are placed on wood platforms for transportation by lift trucks.

FIG. 9 STANDARD STEEL TOTE BOXES

Note the rack on the right. This can be put in to make a specialized container for gears, etc.

Operators working on a piecework basis will not try to claim pay for the full amount of the order if some parts are missing, as the evidence of such missing pieces is open to the time clerk and the foreman at a glance. In the matter of placing the responsibility for scrap, it is very easy for a foreman to check the actual amount of material coming into his department in order to be sure that the Production Order shows the amount scrapped on previous operations. This is a factor frequently overlooked in the design of equipment to move material.

7. Permanence. Permanence requires substantial design—steel construction well braced with heavy wood members. It should be remembered that trucks get some hard knocks during their daily travels, and should be designed to remain in service as nearly continuously as possible without going to the repair department.

When the material handling system of any factory has been remodeled in the light of the seven ideals of economy of floor space, minimum handling, efficient loading, speed and safety in transportation, flexibility, speeding up the work and permanence, one important step has been taken towards the greater ideal of coordinating the manufacturing and material elements of a plant so that every process, machine, and truck is linked into one smooth running and efficient unit.

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The Engineer's Relationship to the Executive

By RALPH L. PADDOCK
Production Engineer

IN the first issue of MANAGEMENT ENGINEERING there appeared in the editorial column the following statement of policy: "MANAGEMENT ENGINEERING seeks to help these executives—the men of management—better to discharge their duties in preparing, organizing, and directing industry to secure maximum production."

To help executives do these things is of course one of the prime tasks of the engineer. However, the question arises—How are we engineers going to accomplish this? There is one factor to which we have evidently been blind and which undoubtedly is the cause of our not attaining the splendid results that otherwise would be ours. That factor is our failure to understand the executive, and on the other hand our failure to make him understand us. And it is to our discredit that rarely do we make any attempt to understand him. The following incident brings out the situation forcibly. Recently the president of an aircraft company, taking up a letter, said, "There's a letter

from an engineer which I can understand perfectly. Most of them write about things which only they can understand."

We engineers speak our own language, the executive speaks his. He talks in terms of sales, balances, profits and loss, and in valuation of output. "Last year we did a gross business of over seven million dollars, this year we will do about two-thirds of that amount." He thinks of the volume of advertising and the number of salesmen necessary to increase his gross sales. He thinks of manufacturing new articles to catch the public taste. Never, or rarely ever, does he lay any stress on what the factory can do to sell his products. He ignores the very thing we engineers are primarily concerned about—the factory. To him it is a means to an end. If anyone talks prices and costs to him and gives him an array of figures showing what each department is earning, he understands perfectly, and for that very reason the accountant gets a better chance with the executive than does the engineer.

Formerly lost motion meant absolutely nothing to the executive, and it would have continued to mean absolutely nothing if the loss because of it had not been translated by Mr. Gantt into dollars and cents. On the other hand engineers fail to understand why an executive pores over sheets of figures when a simple glance at a curve would give him all he wishes to know. We fail to understand under what environment the organization was built up, we make no attempt to learn its traditions, its customs, or its characteristics. We take it for granted that the factory is in sympathy with us, whereas we should take pains to see that we are in harmony with it.

THE EXECUTIVE'S FAILURE TO UNDERSTAND ENGINEERS

The average executive who has long been associated with a plant has no conception of the amount of unnecessary waste there. He has become so accustomed to seeing waste all around him that he does not notice it, or if he does notice it he feels it is a necessary evil. A foreman who is complained to about the noise of his machinery and told that it should be lessened says, "We don't notice it. If you stayed here long enough you would get used to it." It is hard for engineers to understand how the foreman can allow such noise, and how the executive can tolerate the waste due to lost motion, to design, to improper flow of material. For instance, during the construction of a certain large factory addition consisting of five floors the foremen were given the choice of location, with the result that between two floors the material flowed up and down eight times instead of twice only. Naturally when the plant ran full capacity the elevator was overtaxed and the management did not know that poor planning was the cause of this. They had even gone so far as to plan for another elevator without knowing why the one in operation was overcrowded.

Now, just as the executives in this case failed to recognize the cause of trouble, so we often fail to understand the executive mind, fail to understand why he can't see things as we see them. We speak to him in our own language, and he replies in his. He is under no obligation to learn our language, but if our work is to prove successful it is necessary that we should learn his.

The engineer has faults just as has the executive, and he should ask himself if it is fair to lay at the executive's door all responsibility for the present upset business conditions. The Communists in Italy were sure the industrial plants could be run without the executives and engineers, but it did not take them long to find out their mistake. Likewise the engineer thinks that were he head of an industrial plant he would show the world a thing or two. The engineers have accomplished much through their efforts, and the present writer has no desire to discredit these efforts, but to assume that engineers are capable of teaching the executive everything there is to know about his business is ridiculous.

THE FUNCTION OF THE MANAGEMENT ENGINEER

That the management engineer has a most important field to fill is unquestioned, but that his work is paramount to that of the president of a company is an obvious exaggeration.

Frequently one will run across a plant in which an engineer has instituted certain reforms, only to find the original work obliterated for no other reason than because the engineer failed to understand the company's traditions. So long as such instances occur the management engineer can be classed with the executive as a waste maker.

Put yourself in the executive's place in the following cases. If you were superintendent of an industrial plant in which a cost system was installed, a system which tells you your costs after the article is shipped—too late to aid in lowering the costs of manufacture—and a couple of thousand dollars monthly had been spent for its maintenance, simply to furnish you a *history* of costs, how would you feel about it?

If you were general manager of a plant and had put one-half of your product under control, only to discover that the product not under control went through the factory just as quickly, how would you feel with regard to the time and money spent for a system which did not function?

Instances such as these could not have occurred had the engineer understood the executive and the factory conditions as well, and had he introduced his system in such a way as to make his work become part of the plant, something which could not be eliminated later on. The whole thing comes down to this, that the engineer must understand the traditions of the plant, must work in harmony with the plant, and must learn the president's trials and difficulties in such matters as disposing of unsold goods, directing the purchasing of raw material in a falling market, adjusting wages, facing industrial unrest because of reduced wages, and refusing to declare a dividend on account of poor sales. Till such a common ground of understanding is reached, the engineer will not attain that measure of success which might otherwise be his.

Measurement and Errors in Manufacturing

The Starting Point of Production and the Control of Quality

By G. S. RADFORD*

Consulting Management Engineer

MEASUREMENT is the foundation upon which the exact sciences rest. Since the manufacturing arts are (or should be) but the application of the laws of science in practical form to meet our daily needs, then it follows also that measurement is the proper starting point in the arts just as it is in the work of pure science. In fact, it has long been recognized that the degree of accuracy with which measurements are made, is the best criterion of progress in the arts. The process of measuring permits comparisons to be made and recorded in form for use. By it we may note the differences and likenesses of similar things, also the degree of such likeness or dissimilarity; and these are the things that show progress. Some changes show retrogression, and others indicate improvement; but without the ability to measure them, it would be quite impossible to advance either science or art in a way sufficiently systematic for practical usefulness.

The Evolution of Measuring

When the attempt is made to manufacture a number of like things, some sort of measuring process is absolutely indispensable. Hence the importance of understanding what the process involves. The history of the development of the standards of measuring (used here in its widest sense to include weighing) would be called "intriguing" by the modern novelist, for it presents a specially interesting and fascinating picture of man's material progress.[1] It does not serve our present purpose, however, to digress in that direction, further than to note the rise of accuracy that has accompanied the evolution of our present standards. It is relatively only a short time ago that the most precise and scientific laboratory methods were quite incapable of realizing the accuracy that is commonly attained in modern shop practice with much less effort and care. Furthermore, we are able to measure many things today that our forbears never thought of measuring—and the end is not yet.

There is one feature of the evolution of measuring, nevertheless, which we must consider if we are to understand each other in what follows. It is not historical, but rather is it illustrative of the procedure which must be followed if we are to develop, in a logical way, the processes of measuring necessary for controlling quality in manufacturing.

The Selection of Characteristic Qualities

By way of approaching the matter, suppose we assume that we have to make a quantity of things, bricks perhaps. They are to be as nearly alike as may be consistent with the commercial restriction of economy. Let it be assumed also that we have no means or scheme of measurement. The first step necessarily must be in the direction of selecting the characteristics in which the articles are to agree. These characteristics, which determine the quality of the article, are, of course, sensed and evaluated by us through the physical means with which we perceive them. Thus if we were concerned with bricks, the essentials would be shape or form, size, strength, weight, surface finish, color, and so on. For practical purposes, we could get along very nicely without paying any attention to any of these things except shape, size, and strength; but as the art of brick making progresses, the demand increases for greater uniformity in the less utilitarian and more aesthetic characteristics.

The economist says that manufacturing as a process inhibits making beautiful things.

> Individuality is the essence of art; to be beautiful it would seem that a thing must bear the impress of its maker's personality. There is little room then for specialization in the making of beautiful things. If we want the material apparatus of life to be beautiful, we must be content with less of it; we must choose between a great many ugly and ordinary things and a few beautiful and unique things.[2]

This statement is true only if we are content to permit it to be true. It should be a pleasant duty for the manufacturer to dispel this somewhat common, although fallacious, belief; and the way to do it is by the first step just indicated. Keen and searching analysis of our product will show the characteristic qualities, some of which contribute to its usefulness while others make it pleasing to the senses. Economy of manufacture reaches its greatest efficiency when every characteristic is controlled to uniformity with deadly accuracy; but its product need not be ugly or lifeless unless we choose to ignore all but the most utilitarian

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* Mr. Radford was graduated from the United States Naval Academy in 1903, and from the Massachusetts Institute of Technology in 1905. From that time until 1908 he was assistant superintending constructor at the Fore River Shipbuilding Company, then for two years shop superintendent of the Norfolk Navy Yard. From 1910 to 1915 he was assistant to the chief constructor, United States Navy, in charge of Navy Yard production and management matters. In the latter year he became production engineer at the Bridgeport plant of the Remington Arms Company, and soon after the outbreak of the war, manager of the contract division of the Emergency Fleet Corporation. This position he held until 1918, when he took up consulting management engineering.

This article is a chapter from Mr. Radford's forthcoming book on the subject of The Control of Quality in manufacturing.—Ed.

[1] See "The Progress of Science as Exemplified in the Art of Weighing and Measuring," by Prof. Wm. Harkness, U. S. Naval Observatory—presidential address before the Philosophical Society of Washington, 1887. (In Smithsonian Report, 1888.)

[2] Henry Clay's "Economics for the General Reader."

qualities. If the model is beautiful, its beauty can be repeated indefinitely, with proper care and attention to the pertinent details; a business in which little things become paramount. Is not the modern automotive engine an article of beauty? It is made so by precision manufacturing, which also makes it an article of commerce. If it could be made and was made by the "individualistic" methods of the artist, no ordinary man could afford to own one; nor would the automotive art have made such rapid strides.

The Selection of Standard Samples

Having selected the characteristic qualities which we wish to have alike in all the articles we are to manufacture, the next step involves the selection of a standard of comparison, and this standard must always be some tangible physical thing. To return to the case of the brick, we probably should select a brick and say: "This is of the shape and size wanted. We will call this our standard sample for shape and size." Then perhaps we might select another as the standard sample to show the desired color.

As a matter of fact, the method of comparison by using standard samples is the accepted practice in more than one industry. In many cases it has to be. Suppose you are making cigars. The tobacco must be graded in several ways, as well as by odor, and possibly taste, to secure the desired bouquet. There is no instrument as yet to measure such qualities—nor is there even a classification of them. Any uniformity that is secured must be by comparison with some sample or samples arbitrarily selected as standard; both as regards raw material and finished product. Even if samples are not at hand, they exist in the memory of the expert whose judgment is relied on for the grading; and the statement still holds in principle.

Color is measurable, but the methods and apparatus find little application as yet outside of the physics laboratory. The principal industries in which color is a dominating quality, such as the textile and similar classes of industries, have made the first big step toward standardizing by the adoption of the so-called "Standard Color Card," which shows the colors that have been adopted as standard in the form of classified standard samples.

The selection of a standard sample hardly can be called measurement. It is rather the first crude step toward measuring, as we understand it, when speaking of weight or dimension. But it is a very necessary link in the chain of development. Perhaps it may be asked, why carry the process further if such samples will serve the purpose? The answer is best found in the consideration of what we must assume when we use standard samples for comparison.

The first assumption is that several samples are sufficiently alike for practical purposes. If we have a number to choose from, we may reasonably assume this to be true, *but only up to a certain degree of likeness.* Further progress toward general uniformity is blocked when that stage is reached.

The most dangerous assumption we must make, however, is that the standard sample will not change with time. It is bound to change. That is one of the few great laws of nature we are sure of. Everything changes all the time, and very few samples indeed could be found that would not alter perceptibly—if we had anything to use as a measure for detecting the change. What is more to the point, the oftener we use our standard sample in practice, the sooner does it alter in the very characteristic for which it was chosen as a standard of comparison. Our old friend the brick would soon wear and abrade away from its original size and shape if we used it to compare with new lots of bricks. Also, the one we selected as a sample of the desired color would be quite sure to fade with exposure to light, or grow darker from handling. At best, any system of uniform manufacturing which is based on standard samples alone, requires that the most unusual precautions be taken to safeguard the standards. The use of master gages and the care required in gage checking is an example of this sort.

Measurement by Comparison With a Scale

The next move toward a more efficient means of making comparisons in order to secure uniformity of product is in the direction of greater general usefulness, simplicity, and permanence of results. Convenience, if nothing else, requires that we obtain a standard of more general applicability. Suppose we take dimension as the quality to illustrate this. Once we assume an arbitrary standard of length with a suitable scale of divisions, we can dispense with the business of comparing brick with brick, so far as dimension is concerned. In fact, with such a means of measurement, we are in shape to compare dimensions by themselves, without regard to the particular articles whose size is involved. Thus the idea of true measurement appears, because we are able to reduce our comparisons to the abstract form of figures. Any dimension is then expressed in the form:

$$\text{Measured length} = \frac{\text{Given length}}{\text{Standard of length}}$$

The point to be borne in mind is that when it becomes desirable to carry the control of quality beyond the standard sample stage, the first step is to develop a graded scale which will permit us to express the measure of the quality in figures. The latter secure for us a reasonable independence from the dangers of standard samples. Needless to say such a scale itself is always, in the last analysis, based on some tangible and arbitrarily selected object which is taken as the general standard. But its general usefulness and wide application warrant the precautions necessary to insure permanence. Thus dimension and weight, which have been carried to the practical limit in their evolution, may be taken as amply safeguarded. The standards in this country are represented by certain weights, bars, etc., which are kept in the vaults of the Bureau of Standards in Washington (see Fig. 1). Thus you see, all our measures refer back to certain objects which are arbitrarily selected as the standards. The standard of length is now reproducible for any reasonable re-

quirement of accuracy, because its measure is known in terms of light waves. Nevertheless it is still true that we cannot get away from an arbitrarily chosen standard even then; because we must use a given light wave such as sodium, and the light must be made or taken from sources selected as standard, and measured with a certain definitely selected and calibrated equipment.

The choice of the fundamental units for measurement should be made with care. They should be convenient, should permit accurate comparisons with other

FIG. 1 THE STANDARDS OF WEIGHT AND LENGTH FOR THE UNITED STATES KEPT IN THE VAULTS OF THE BUREAU OF STANDARDS AT WASHINGTON, D. C.

quantities of the same kind, and should permit of accurate comparisons regardless of time and place. Scientists ordinarily use as fundamental units for physical measurements, a definite length, a definite mass, and a definite unit of time. Most of our ordinary measurements are based on these units or some combination of them, e.g., electrical measurements. Characteristic qualities, which are not measured outside of the laboratory as yet, usually will be found to be measurable in terms of three constants. Thus sound is measurable in terms of tone or pitch, amplitude and timbre. This indicates a line of attack if you are confronted with the problem of measuring noise due to vibration. The color constants are hue, purity or chroma, and luminosity of brightness.

The final step in the evolution of measurement is the development of instrumental means for making comparisons. Their need springs from the desire for greater accuracy, which requires the use of something that is less subject to personal error and differences from individual to individual. This impersonal quality of the instrument flows from the fact that it is more positive in action than any unaided comparison by means of our senses can possibly be—a result that is accomplished ordinarily by enlarging or magnifying differences in reading, so that errors may be detected with greater ease.

By using a finely calibrated scale, for example, one soon reaches a point where finer readings are impossible. Further progress toward greater accuracy is blocked when that point is reached. Suppose the scale is a high-grade flat steel scale 6 in. long, marked off in fiftieths and hundredths of an inch. If you apply it in the attempt to measure a block of steel, say about 4 in. long, you will have considerable doubt as to which of two of the hundredths marks is the closest to the block's size. If the block is longer, the difficulty becomes greater; and if it is longer than the scale, an accurate reading is much harder to obtain. The use of a magnifying glass permits closer reading, but the use of an end-measuring instrument which makes positive contacts, in place of side-by-side comparison, renders possible a much greater precision of measurement.

THE MEASURING INSTRUMENT

The use of instruments permits the application of means for enhancing errors and thus permits closer reading. No instrument is worth using in the factory, however, unless it is sure to measure more accurately than can be done without the instrument. At first thought this may seem foolishly true, but it seems so only at first thought, for the reason that some instruments are apparently more accurate merely because they are sensitive. An instrument has great sensitivity when it answers, or shows a change in reading, for a very slight change in the thing being measured or in the conditions under which the measurement is made. It is desirable to note this difference between sensitivity and accuracy, because the two are sometimes confused. A balance whose indicating pointer answers to a very slight change in weight, may still be quite inaccurate.

The converse is true also, because an accurate instrument may lack sensitivity. In the latter instance the fact should be known, because it sometimes happens that the lack of sensitivity results in a lag. It is therefore important to know how long it takes a sluggish instrument to show a correct reading. But if you are to know what degree of accuracy an instrument is capable of showing you must be equipped to check its precision, and this requires a more exact standard for checking purposes.

In this discussion of instruments it will be noted that no attention is being paid to certain general requirements for measuring apparatus with which everyone is familiar; such as ruggedness, precision, facility for making direct measurements without corrections, general suitability to the requirements of the work, and so on. It is desired, however, to direct attention to some of the qualities in such instruments which are fre-

quently overlooked and thus make accurate measurements out of the question. One of these oversights, as a case in point, is what may be termed an "overgraduation" of the instrument. One of the great dangers faced by the technician, as by everyone else, is that of fooling oneself. It is vitally necessary in manufacturing to be sure of our facts—especially as to measurement. Therefore an instrument which is calibrated to permit closer readings than it is capable of making is to be avoided with care, or at least used with a knowledge of its probable error.

Measurement and Accuracy

Every once in a while you will find a factory whose drawings call for exceedingly close adherence to the absolute dimension, although the shop is not equipped *except by the markings on the instruments,* if then, to work to any such degree of accuracy as is prescribed. Usually all hands are quite sincere in believing that they attain the requirements stated on the drawings, but they merely fool themselves. Why do so, however, when it is so easy to possess the truth?

Not very long ago the chief inspector of a factory, whose work required a high order of accuracy for a very special sort of work, was asked to produce his final standard of dimension. He pointed out the usual standards supplied with micrometer calipers. His questioner said: "But I asked you to show me your final standard—your 'court of last appeal.'" The chief inspector blushed, and said: "We haven't any!" Later he added in self-justification, "I've asked for gage blocks many times but they never gave them to me."

By the same token, it is an equally erroneous practice to expect accuracy when the instruments provided do not permit of close enough reading. A pressure gage with a 2-in. dial, calibrated by 5 lb. intervals, will hardly permit the process to be held to closer than 5 lb. Yet just such a case came to light during the recent overhauling of a process in which a close adherence to a given standardized pressure was vitally important for securing a uniform product from that process. It is questionable as to which is worse—a mechanic who thinks he is doing accurate work because an inaccurate instrument says so, or one who is trying to do accurate work without a clear reading instrument to guide him. Neither condition need exist, which makes their occurrence all the more lamentable.

In step with the preceding is the failure to realize that practically all instruments are less precise over a part of their range than they are for the greater part of their range. Furthermore, at the part of the range where greater errors occur, the measurements are likely to be subject to greater variations under different conditions of use. This is true in marked degree for the smaller readings of instruments which are inherently afflicted with an initial friction. It is true also, for instruments whose design and construction involves backlash; and, naturally, the maximum errors may occur where the backlash may develop to the greatest degree. As an example of error resulting from initial friction, consider a balance. It may be extremely accurate for large weighings, but will show very large errors indeed for weighings made at the threshold of its scale. In other words, the smaller weighings should be made on a balance of smaller total capacity, as the smaller readings are thus expanded to a size that is perceptible. In short, the conclusion is inevitable, that the instrument should be chosen with reference to its capability to meet the requirements of a given situation. It must not be expected to meet all requirements. You cannot weigh everything with one huge pair of scales. But the way to determine the suitability of the instrument, or to select a suitable instrument for a given purpose, is to be prepared to check the work of that instrument by some superior method of measurement, which is *many times more accurate than the instruments* which are being checked. Otherwise you cannot be sure of your facts.

Precision in Measurement

In developing a method or process of measuring, it was observed that the first step involves the use of an arbitrarily selected standard for comparison. Presently a point is reached where observations fail to agree, and this point fixes the limit of precision obtainable by such method. So we are forced to seek further improvement by devising a scale of more general applicability and permitting not only of stating measurements impersonally in the form of abstract figures, but also securing an additional degree of accuracy in most cases. But this method soon reaches its limit of precision, and further progress toward more exact measurement must make use of still more impersonal methods by means of instruments. While this last step usually gains much greater fidelity to the absolute measurement, nevertheless it too reaches an ultimate limit of precision, beyond which measurements of the same thing under like conditions are not in agreement. This situation follows an earlier stage where measurements by different observers, working under the same or slightly different circumstances, do not check.

Inevitably, then, we reach a certain critical point for any given set of conditions, where error enters, and this is entirely apart from the ever-present assurance of occasional accidental errors. Of course we know that errors are bound to occur—the theme of our study has been throughout, that quality is varying continually—consequently the readings of our measurements of quality will vary.

The term "precision" is a confession that absolutely correct measurement is impossible of realization. Accuracy means exact or careful conformity to the absolutely true standard. Absolute accuracy implies freedom from error, hence for practical purposes we are forced to speak of the degree of accuracy rather than of accuracy itself. Precision is a shorter term than degree or rate of accuracy, and means the same thing. Consequently precision is a percentage of the measurement. Thus, the precision of Swedish gage blocks is stated as, say, one-hundred-thousandth of an inch *per inch* of length; and strictly speaking, we should always

state precision in that form. The attitude of the physicist toward these terms is:

When the true value is known the *accuracy* may be expressed as the difference between the experimental quantity obtained and this true value. Since, however, the exact or true value is seldom known, the accuracy of the result cannot be stated, and it becomes the more imperative to have methods of estimating the precision measure or reliability of the result of a series of observations.[3]

Now, just as there is a limit to the precision of measurement for any given situation, so is there a limit to the precision of workmanship that is possible for any

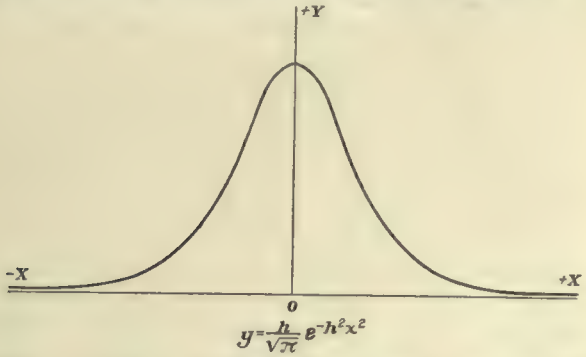

FIG. 2 PROBABILITY CURVE, SHOWING THE FREQUENCY OF OCCURRENCE OF AN ERROR

given process or operation. And this limiting precision in manufacture follows after and is dependent upon the attainable precision of measurement of the work produced by said process, whether the measurement be made by a highly developed instrument or by mere visual comparison with a standard. What is true of the *possible* precision, is equally true of the precision that it is sensible to use commercially; for cost will enter as the determining factor in the selection of the degree of accuracy best suited to a particular case.

Whether the attempt to increase precision should be made is a matter of business judgment, and calls for a sensible decision. A military gun stock demands much closer fidelity to accurate dimension than does wooden furniture; but it would save a deal of profanity if desk drawers didn't stick. The stores are full of all kinds of goods that indicate the same situation. It is a mistake to say that anything is good enough, for there must be some one dimension, for example, that is best suited to any special case. If the article, as designed, is best suited to the job, our constant endeavor should be to obtain a closer and closer adherence to this ideal standard. This means the refinement of manufacturing through the reduction of errors—an undertaking that should be inaugurated by a study of errors themselves.

THE THEORY OF ERRORS

The most valuable thing to realize about errors, so it would seem, is that they always have a tendency to occur. Possibly this is not a peculiar idiosyncrasy of errors alone, and they follow the general rule that it is easier to be bad than it is to be good. So we can only reduce errors by the vigilant use of foresight, care, and thoroughness to hold them in check. They are, moreover, like a snowball rolling down hill, because they tend to accumulate others of their own kind.

A knowledge of the theory of errors is so important in accurate physical measurements that considerable attention has been given to it, and several substantial literary contributions have been made. The application of their conclusions is too much confined to the physics laboratory, however, and should be more generally understood by manufacturers. The physicist starts off by making a distinction at once between mistakes (or mere blunders) and errors. In the factory, mistakes are the order of the day, and their best prevention lies in the direction of checks by independent methods of one sort or another, as has been indicated early in this work.

Individual vigilance and the habit of doing everything in a careful and orderly manner are the only means of reducing such inaccuracies to a minimum. It is often highly advisable to run some rough independent check experiment or to test the final results with common sense to see that no gross blunder has been committed.[4]

Prof. H. M. Goodwin, in his "Precision of Measurements and Graphical Methods," classifies errors as *determinate errors*, whose value can be determined and their effect eliminated, and *indeterminate errors*. He classifies determinate errors as:

1. Instrumental errors, due to faulty adjustment or construction of the measuring instrument;
2. Personal errors, due to the "personal equation" of the observer; and
3. Errors of method or theoretical errors, due ordinarily to using an instrument under conditions for which its graduations are not standard or correct.

It will be observed that some errors lead to incorrect conclusions, in spite of the fact that several measurements may be in agreement. Thus if the instrument is out of adjustment, or if the observer is, by nature, generous in his readings, so that he constantly errs on the high side of the measurement; or if the instrument is standard at 68 deg. fahr., but is used at 90 deg. fahr., the measurements may in all cases agree and still all be in error.

As to *indeterminate errors* (accidental or residual) Goodwin says:

Experience shows that, when a measurement is repeated a number of times with the same instrument and by the same observer under apparently the same conditions, the results usually differ in the last place or sometimes last two places of figures. Thus in so simple a measurement as the determination of the distance between two lines with a scale graduated in millimeters, successive measurements will not agree to one-tenth millimeter if fractions of a millimeter are estimated by the eye.

Such errors have been found to follow the law of chance, which may be plotted graphically as shown in Fig. 2 from the equation:

$$y = \frac{h}{\sqrt{\pi}} e^{-h^2x^2}$$

in which y is the frequency of occurrence of an error of magnitude x, h is a constant related to the reliability

[3] Taken from "Precision of Measurements," by Prof. George V. Wendell and Prof. W. L. Severinghaus, of Columbia University.

[4] *Ibid.*

of the observations and called the precision index, e is the Naperian logarithmic base (2.7183) and π is the constant 3.1416.

It will be observed from the curve that:

"1. Small errors occur more frequently than large ones.

"2. Very large errors are unlikely to occur.

"3. Positive and negative errors of the same numerical magnitude are equally likely to occur."

This law assumes an infinite number of observations, but is reasonably true in most cases for a comparatively small number, hence its value as a guide. It presupposes, however, that the observer is trying to attain absolute accuracy as nearly as may be; and, in the case of factory workmanship, this is where practice frequently departs from theory. Being sane, the workman will do what he believes to be to his own best interest. Consequently if there is a penalty attached to spoilage he will deliberately keep on the safe side, since in that way he has a chance to repair his errors.

An Application of the Law

Consider for a moment the case of a 2-in. shaft, which has a tolerance of 0.0004 in. If your limits are set $\frac{0.0004 \text{ in.}}{0}$ (i.e. allowed 0.0004 in. over and 0 under dimension) the greater part of the work will hug 2.0004 in.; because the operator will stay on the safe side and work toward the full dimension. If that is what you want, well and good; otherwise the tolerance should be split up to allow for this tendency. In closer work especially, it would be better practice to set the limits as $\frac{0}{0.0002 \text{ in.}}$ instead of $\frac{0.0002 \text{ in.}}{0}$ or $\pm$ 0.0001 in. The probability and chance would thus favor securing more work to the desired ideal of 2.0000 in.

If all errors were equally distributed as to size and occurrence, plus or minus, they would cancel each other to a large extent. In the factory they do *not* do so, but accumulate too rapidly for comfort. There are several ways in which this occurs, and happily there are several ways to meet the situation.

First there is what may be termed a chain of inaccuracy due to a slip in the transfer of measurements. The master or reference gage is not quite like the model; the reference gage template is not quite like the gage and so on. This error is negligible when a very precise method of measurement is available for checking purposes.

Then there is a chain of wear, resulting in *systematic* and progressively increasing error. Granting the availability of more precise control apparatus, the answer is, again, checking with sufficient *frequency*. As to the mechanical side of intentionally lessening wear, there is room for considerable discussion and the resulting conclusions are widely applicable—to tools, to measuring devices, and to the product itself. Prof. John E. Sweet was the great apostle in this field as in many other practical problems. In 1876 or before, he advocated the use, and pointed out the advantages of equal length wearing surfaces; i.e., the first "straight-line" engine had a cross-head and guides of equal length, which, after years of use, showed practically no wear. In 1903, he stated "*Things that do not tend to wear out of true do not wear much.*" This principle is worthy of much consideration. Please note the present tendency toward the use of gages with wider and larger anvils (or bearing points); although there are other causes than wear at work, since such gages tend to give more accurate results.

Incidentally it may be noted that we may profitably extend the above to include the idea of *even wear* for a number of like parts. Thus if everything wore at the same rate, progressive errors would accrue, but their effect would be less, due to the averaging process going on, and thus tending to hold to uniformity. Take a multi-cylinder automotive engine; if one of the several piston gudgeon pins is a poor fit, all will tend to wear out of adjustment. Suppose, even, that all the pins are fitted with beautiful exactness by hand-reaming, but that some are larger than others. Will they wear evenly? Will they continue to remain in adjustment as perfectly as if all were almost exactly alike? Furthermore, not only does the idea of even wear bear upon this matter of uniform dimension, but also upon the question of uniform hardness, uniformity of material, quality of finish, and so on.

The Cure for Errors

The cure for most errors will suggest itself as soon as a determined effort is made to locate and cure the causes. They must be hunted down and stamped out at the source whenever possible. Then again they may be reduced by putting processes under uniform control, and through averaging the errors by spreading them out evenly. The experience of Whitworth in creating the first accurate surface plate reveals a valuable lesson. By using three plates, and alternately comparing them by contact, then scraping off the high spots, he used the errors to destroy each other and thus created the basis of all our machine shop precision—a true plane surface, relatively speaking.

The concluding observation to be drawn from the study of measurement and of errors, beside the very obvious necessity for care and thoroughness in great detail, is the need of providing control apparatus for the qualities with which we are concerned. To be effective, such apparatus must be safeguarded and is even then useful only in so far as its use and the conditions surrounding its application are freed from possible causes or error.

The fact that means do not exist at the moment for measuring some of the characteristic qualities with which industry is concerned, merely serves to indicate the direction in which the start should be made toward conscious improvement of these qualities. If industry makes the demand on science to develop principles, practices, and equipment to meet its requirements, the needful things that are now lacking will be supplied.

The Gantt Chart—IV

Its Application to Plant Load

By WALLACE CLARK*

Consulting Management Engineer

THE purpose of the Gantt Load Chart[1] is to keep the executives of any producing plant advised as to the load of work ahead of their plant. This information is of particular value to managers, superintendents, foremen, employment departments and sales departments, for it gives them an accurate picture of the work which is to be done, and it is necessary to have a clear understanding of what is to be done before effective steps can be taken to do it.

The Load Chart is similar to the Layout Chart in that it shows how much work is to be done, but it is more compact than the Layout Chart and does not show details. Layout Charts show each operation on each order and the individual machines which are to do the work, but a Load Chart merely shows classes of machines and the hours of work assigned to them by weeks or months. The drawing of the Load Chart is similar to that of the Progress Chart so far as light and heavy lines are concerned; but the similarity ends there, for the Progress Chart shows work done and lines are added as more work is done; but the Load Chart shows only work which is *to be done* and represents the status of plans at a specified date. It is not a record added to day by day, but an analysis of a situation at a given moment.

How the Gantt Load Chart is Drawn

At the left of the sheet are listed the classes or groups of operators, machines, work benches or floors, and in the next column the numbers in each group. In the columns representing months or weeks, the figures indicate the number of operating hours for a group of men or machines; the light lines show the hours of work which have been assigned to that group during each week or month; and the cumulative lines represent the total hours of work ahead of each group. The information for this chart is secured from Layout Charts which show what orders are ahead of each machine, and from this it is easy to foot up the hours of work planned for the various classes of machines for each week or month.

When the amount of work ahead of a plant is placed before an executive on a Load Chart, it is possible for him to so grasp a situation that he can adjust equipment, operators, and working hours to the work ahead or adapt the work to the equipment and operators.

If there is *too much work* ahead, he can secure information from the Load Chart as to:

1. Deliveries to be quoted on future orders.
2. What kinds of orders must be refused.
3. Where congestion is likely to occur so that those processes can be studied and shortened.
4. What additional equipment to buy.
5. How many men to employ and the kind of work they will have to do.
6. What hours need to be lengthened.

If there is *not enough work* ahead, the manager can learn from the chart:

1. What kinds of orders are needed to keep the men or equipment busy (this information is the basis of sales or advertising campaigns, of reductions in prices, etc.).
2. What men to assign to other work.
3. What equipment can be disposed of.
4. What hours to shorten.

In order to furnish this information a Load Chart must be accurate and up to date, but this is not difficult if it is based on Layout Charts such as were described in the second article of this series.

A Foundry Load Chart

In the foundry where the Load Chart illustrated in Fig. 20 was drawn, the main divisions of the work were iron, steel, brass, and core-making; and in the iron foundry, for instance, the secondary divisions were "crane floors," "side floors," "bench floors," and "squeezer machines." The molds for the largest castings were put up on the "crane floors" because they were served by large cranes. On the "side floors" they poured medium-size castings which could be lifted by jib cranes or by hand, and on the "bench floors" and "squeezer machines" they made the smallest sizes.

When this particular chart was placed on the superintendent's desk, he saw that on the "crane floors" of the iron foundry there were 16 molders whose hours per week amounted to 640. For the first week charted 310 hr. of work had been assigned to them, which would keep them busy half their time. For the five succeeding weeks 30 per cent or less of their time would be required. The cumulative line showed him that half a week's work was behind schedule for lack of patterns

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* Mr. Clark was with the Remington Typewriter Company from 1908 to 1917, during the last five years of that period adopting Gantt methods to the management of their executive offices. In 1918 Mr. Gantt put him in charge of his work for the United States Shipping Board in Washington, where he scheduled the operation of all the vessels controlled by the Shipping Board. Toward the end of that year he represented Mr. Gantt on the staff of Gen. John T. Thompson, Director of Arsenals. In 1919 he became a member of Mr. Gantt's personal staff, taking charge of installing methods in several plants. Since Mr. Gantt's death he has conducted his own consulting practice in management engineering.

[1] The present article is the last of a series treating of the principle of the Gantt chart and its application to Machine Records, Man Records, Layouts and Progress of Work. These articles were published in the August, September and October, 1921, issues of Management Engineering.

and other reasons, and that the total work ahead amounted to the molders' capacity for only two-and-a-half weeks, although that work would have to be spread over six weeks.

In the steel foundry, however, the superintendent saw that there was more work to be done on the "side" and "bench floors" than could be done by the molders assigned to those floors. In all there was 12 weeks' work ahead and it was wanted in 7 weeks. It was important to deliver the castings when they were wanted, so the superintendent immediately issued instructions

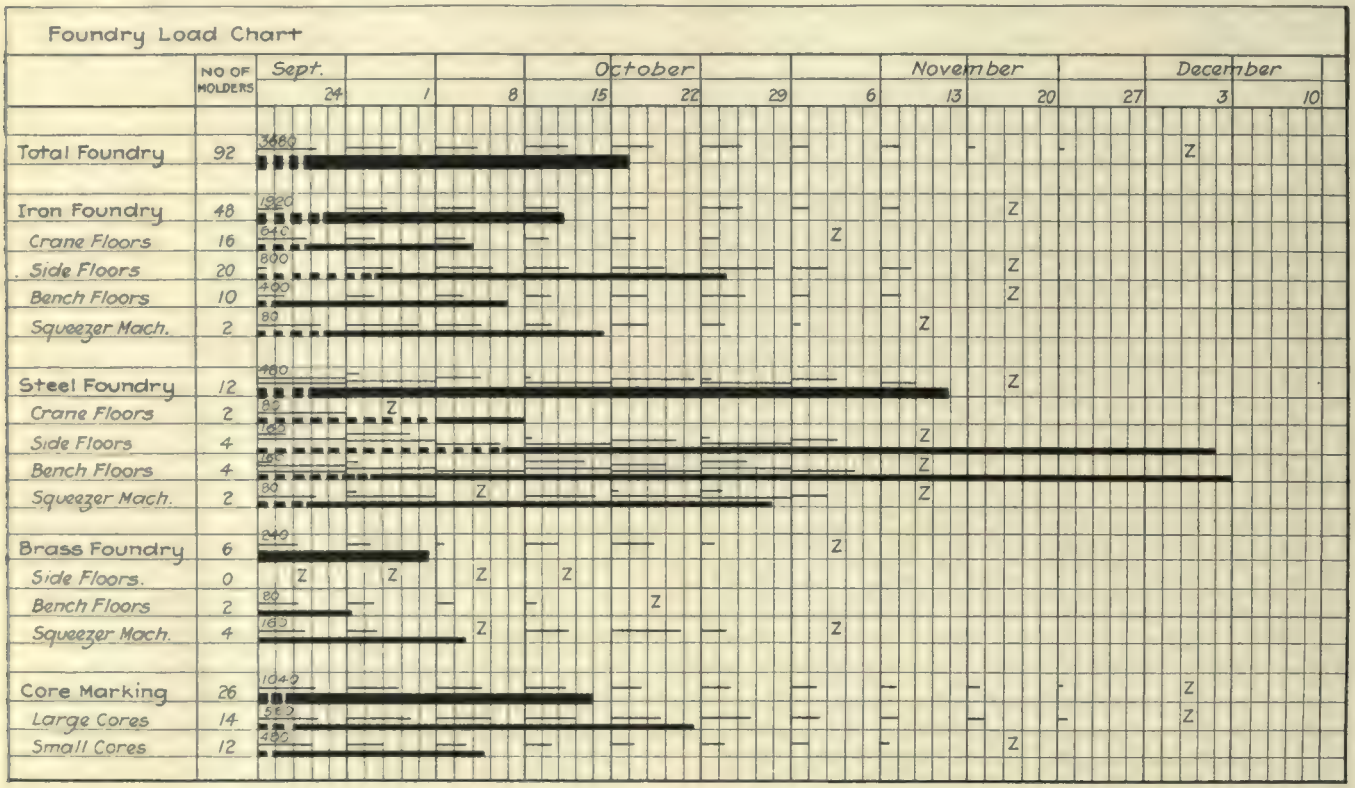

FIG. 20 A GANTT LOAD CHART USED IN A FOUNDRY

to run an additional heat each day, and he transferred two molders from the brass to the steel foundry. He knew that these changes would enable him to make the deliveries promised. In the iron and brass foundries there was not enough work to keep the molders busy, so the superintendent reduced the hours per week until additional orders could be secured.

This Load Chart enabled the superintendent to reduce the idleness in his plant, but, above all, to deliver the castings when they were wanted.

A LOAD CHART FOR MACHINE TOOLS

The Gantt Load Chart shows very clearly whether or not the machine tools in a plant are going to be kept busy in the near future, indicating which ones are overloaded and which have little work ahead. In Fig. 21 the machine tools in shop No. 10 are listed in groups and the lines show what part of the time they will be kept running to turn out the orders in hand. This chart was drawn in a period of dull business and the information was, therefore, presented in two ways, the first half of the chart listing only those machines to which operators were assigned at that time and the second half listing all the machines in the shop. The latter half, therefore, shows well in advance what machine tools will be idle unless more orders are secured, while the first half goes further and, in addition to telling what machines will be idle, shows what operators will have to be kept in the shop in idleness or be laid off if no more work is provided.

In this plant it was not necessary for the superintendent to spend hours in conversation with his foremen in an attempt to learn just how much work they had ahead of them, nor did he have to read long reports; on the Load Chart he had accurate information in condensed form.

A LOAD CHART FOR A DEPARTMENT

In issuing orders for manufacture it is desirable to know what work is already in the plant and when the machines will be free for additional orders. Fig. 22 shows the machines in a shop department arranged according to the sequence of operations. For instance, the first operation on a strap bar was milling and it was done on machine No. 1259; the next was grinding on machine No. 1340, etc. The lines show that the orders then in the department would keep the first machine busy for only four weeks; the second machine, No. 1340, would have no work during the first week and about half a week's work for the next four weeks. The third machine, No. 1401, would be busy all of the first week, but have nothing to do the second week, etc.

The chart emphasizes the fact that the operations

were not well balanced, that is, it took so long for some machines to do their part of the work that those on succeeding operations would have to stand idle a part of the time. For instance, the first machine, although it ran all the time for four weeks, would keep the second and third busy only part of each week. The chart made it clear that the first operation should be speeded up by improved jigs or fixtures in order to manufacture these parts economically.

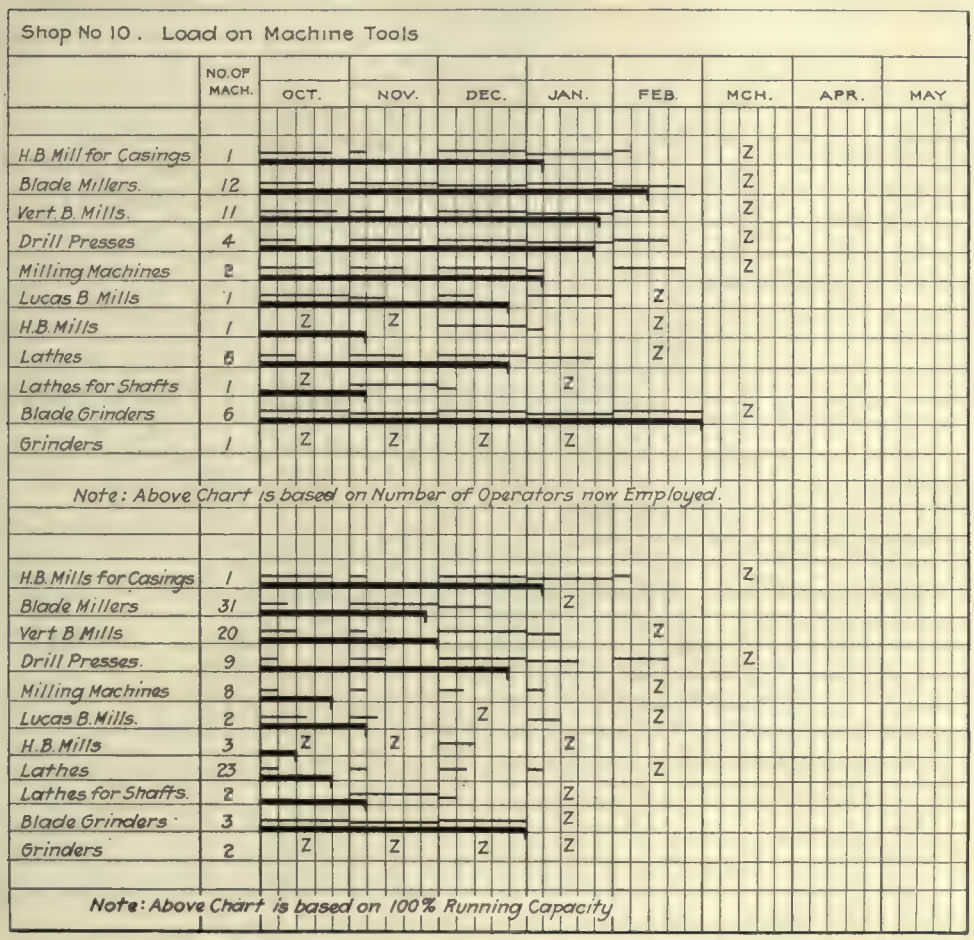

FIG. 21 A GANTT LOAD CHART USED IN A MACHINE SHOP

As to the cutter bars, the chart showed plainly that the orders then in the department could not be completed on the last operation for about 11 weeks, and that the breakdown of a machine or the absence of an operator would have a serious effect on the output of the department.

The amount of work ahead of any manufacturing plant constantly varies, and the management must be able to change its plans as quickly as the work changes. Whatever action is taken must be based on accurate information as to the status of the work at that particular time—not on general impressions which have been carried over from some previous time.

CONCLUSION

The Gantt Load Chart gives the manager or superintendent an insight into the future which it is very nearly impossible for him to get in any other way.

The Gantt Chart shows facts in their relation to time, emphasizing their movement through time, and therefore it compels a man to take action based on the facts shown, just as if he were responding to a force of motion.

The use of a Gantt Chart makes it necessary to have a plan; it compares what is done with what was planned; it shows the reasons why performance falls short of the plan; it fixes the responsibility for the success or failure of a plan; it is remarkably compact; it is easy to draw and easy to read; it visualizes the passing of time, and therefore helps to reduce idleness and waste of time; it measures the momentum of industry.

The Layout Chart helps to plan work so as to make the best possible use of the available men and machines and also to so arrange orders as to secure whatever deliveries may be desired. The Load Chart keeps executives informed as to the amount of work ahead of their plant and enables them to co-ordinate workmen, equipment, processes, orders, and prices. The Progress Chart helps to get work done by showing a comparison of what is done with what should have been done and enables the executive to foresee future happenings with considerable accuracy. It shows the effect of past decisions and points out the action which should be taken in future.

The Man Record and the Machine Record Charts show whether the management is good or bad.

Are the machines being run all day?

Are the men doing a full day's work?

If not, what are the reasons?

The answers to these questions are the ultimate facts in regard to the management of any manufacturing plant. If the men and machines are doing a full day's work, it is obvious that all the other details in the management of the plant are being taken care of on time. Shop orders, production cards, layout charts and reports of all kinds are merely a part of the mechanism which leads up to or follows the Man and Machine Record Charts. They measure the service rendered by the workman, the foreman, and the management.

Each day when a man fails to do a fair day's work the reason is shown on a Man Record Chart. If that failure is due to absence, slowness or avoidable mistakes, it is the fault of the workman, but if his failure is due to lack of instruction, to tool troubles or to a

machine in need of repairs, the fault is with the management. This chart, therefore, measures the service rendered by the individual workman and also the use the management makes of his service. The Machine Record Chart measures the ability of the management to make satisfactory use of the equipment at its disposal. When a machine is not running the reason for its idleness is shown, and from the reason the responsibility can easily be traced. The Progress Chart shows how well the management is organized to get work done.

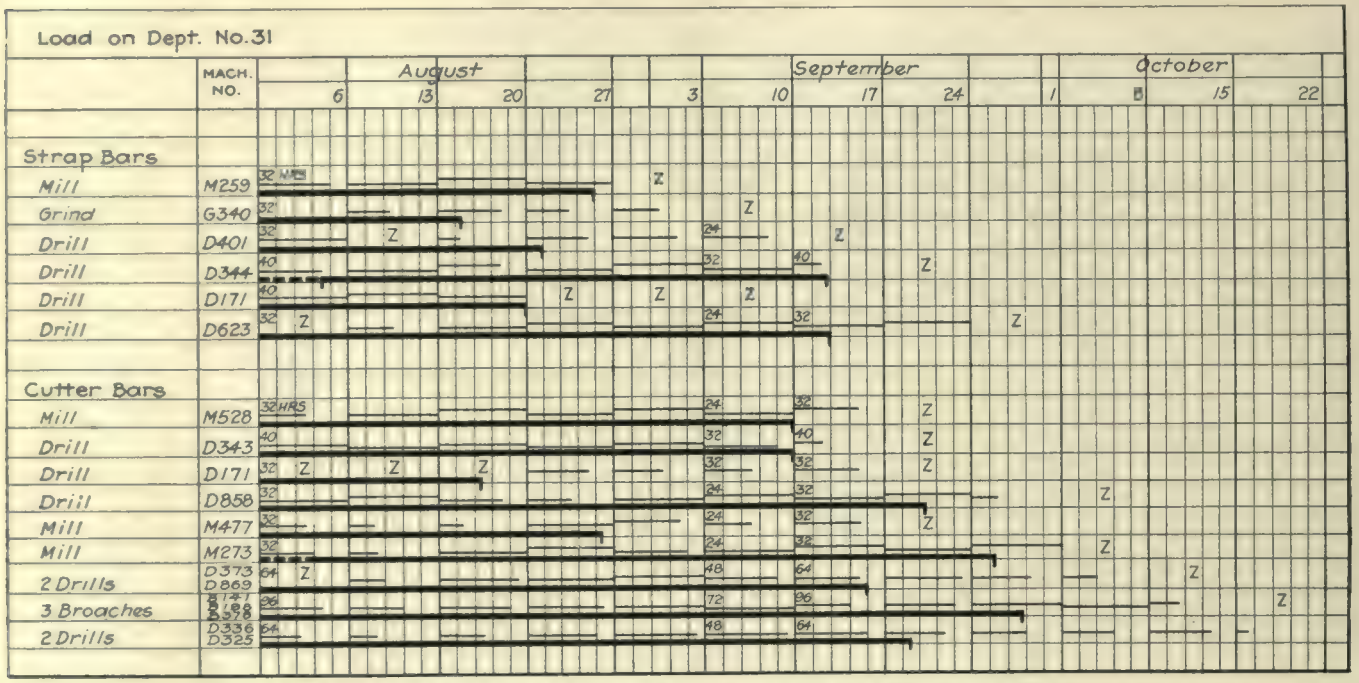

FIG 22 A GANTT LOAD CHART FOR A MACHINE SHOP DEPARTMENT

In the previous articles of this series Gantt Charts have been shown as:

1. A simple and effective method of planning work.
2. A way of presenting facts so that they can be easily understood.
3. A means of eliminating idleness and waste.
4. A method of getting things done on time.

But Gantt Charts stand for something more than that, for where they have been in use for some time you will find:

1. Machines and equipment in good condition.
2. Floor space arranged for use; neither cluttered up with unnecessary things nor arranged for appearance only.
3. Work moving rapidly from one operation to another without confusion.
4. Large reductions in inventories of raw materials, work in process and finished goods, because of the shortening of manufacturing time.
5. Increased production—not so much through speeding up workmen as by removing the obstacles which prevent them from doing a full day's work.
6. Reduced costs, because of the elimination of idleness and waste as well as improvements in processes.
7. Men in subordinate positions willing to shoulder responsibility instead of "passing the buck," because they have definite duties and clear-cut jobs.
8. Courage and initiative stimulated because men know they will get fair play.
9. No favoritism or special privilege, because the charts show facts and every man's record can be seen by others.
10. Satisfied workmen, because the delays over which they have no control are few and they are left free to do a full day's work and, therefore, earn better wages.
11. Poor workmen trained and developed until they make good.
12. Promotions going to men who know their jobs and, therefore, an organization being built up of men who "know what to do and how to do it."
13. Men interested in their work not only because of the wages, but because they have an opportunity to increase their knowledge and improve their skill.

Seeing such changes take place in one plant after another, watching arbitrary management become democratic, and finding workmen not only interested in their work but proud of it, strengthens the conviction that *the Gantt Chart is the most notable contribution to the art of management made in this generation.*

Comparability of Executive Control Charts

A Fundamental Requirement of the "Z" Chart and How It May be Secured

By ARTHUR R. BURNET*

Consultant in Business Statistics

"CHARTS are too slow," sometimes objects the operating executive. "They are after the fact, because I see the figures before the charts are made." This objection, no doubt, has considerable weight where standardized methods of commercial curve plotting are not followed. Charts may indeed be "after the fact" if dollars and tons and other quantities are considered merely as absolute amounts regardless of their relationship to each other. But as a rapid means of determining trends and averages, or computing ratios and percentage increases and decreases, or making estimates of future results, or measuring deviation from a standard performance, charts are decidedly "before the fact."

Whenever the quantitative facts of an industry are to be studied in relation to each other the graphic method is the quickest method. Many operating executives find that time is actually saved if they wait a few hours until the data can be charted before having any figures shown to them.

Relative Comparison

In any industry relative comparisons are more vital than absolute comparisons. This fact is realized most keenly, perhaps, in sales administration. We expect one salesman to sell more goods than another because of geographical and other differences in their respective territories. But the question that really interests the sales manager is whether each salesman, on the basis of his own territory, is doing as much business as he should—the salesman having the inferior territory being compared relatively with the salesman having the better territory. It is always illuminating to compare the part with the whole. If the total sales have increased 10 per cent, what percentage have the sales of an individual salesman or of a sales district increased? Have they kept pace with the "bunch"? Every sales manager knows the force of that appeal.

The same principle holds true for production. Plant A turns out more goods than Plant B when measured in tons or dollars, because Plant A has a larger capacity or because the processes in the two plants differ. Therefore to compare their production directly in terms of tons or dollars is neither fair nor accurate. The comparison ought to be in the form of rates or ratios, disregarding size. Is the rate of increase of production greater in Plant A than in Plant B? Is the unit cost decreasing more rapidly in one plant than in the other? These questions suggest significant relative comparisons that may be observed in properly drawn graphic charts.

Executives may not always realize it, but the fact is that they actually do manage their industries, not so much through their study of columns of figures showing absolute quantities as by mentally computing ratios, and pondering relationships between absolute quantities. Suppose the total pay-roll shows an increase of a certain number of dollars. That may be explained by an increase of production, or the increase may be unobjectionable because the total manufacturing cost has decreased. Or perhaps the total manufacturing cost has gone up, but there will be no complaint here either, if the unit cost has gone down. We are always willing to spend more money if we get more returns. It is the rate that counts. Superficially, we may seem to be most concerned with addition and subtraction, but really we are more concerned with multiplication and division. Graphic charts help greatly at this point.

Misleading Comparisons

In order to demonstrate how the "Z" charts described in two previous articles[1] must be constructed in order to permit of trustworthy or scientific comparisons, let us examine the experimental charts in Figs. 1 and 2. In Fig. 1-A we have a chart containing two series, one beginning with the comparatively small number $10, and the other with a much larger number, $62.50. For the purpose of the experiment, let us assume that the rate of increase is the same for both series, namely, 25 per cent per annum compound interest. It will be observed that the curves for each series are plotted on ordinary arithmetically ruled paper, and that the same scale has been used for both curves. Examining the chart, even the trained statistician could scarcely avoid the feeling that Fund B increases at a faster rate than Fund A, which we know cannot be true because of the assumption made in the beginning. This shows how misleading it is to attempt the comparison of large and small quantities on ordinary coordinate paper without properly selecting the scales.

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[1] Management Engineering, August, 1921, p. 88, and September, 1921, p. 153.

Of course the curves of Fig. 1-A represent satisfactorily the growths of Funds A and B to one concerned with absolute values only. It is indeed true that the larger fund increases by larger amounts at each time of reckoning than the smaller fund. But the man who is interested in comparing the rates of increase will ask: "How might these curves have been plotted so that the eye could perceive the identical rate of increase?" A little reflection leads one to the conclusion that the eye will naturally assume the rates of increase or decrease to be the same when the slopes are parallel or where they coincide; and a little experimentation will bring out the fact that the curves of Funds A and B can be drawn to coincide with each other if the proper scales are chosen, but they cannot possibly be drawn to parallel each other on the same ordinary arithmetic field. Further reflection and experimentation along this line, which need not be detailed here, develop the principle that arithmetic curves are truly or scientifically comparable only when they occupy similar locations on the chart field, i.e., when they are plotted approximately at the same distance above the zero line.

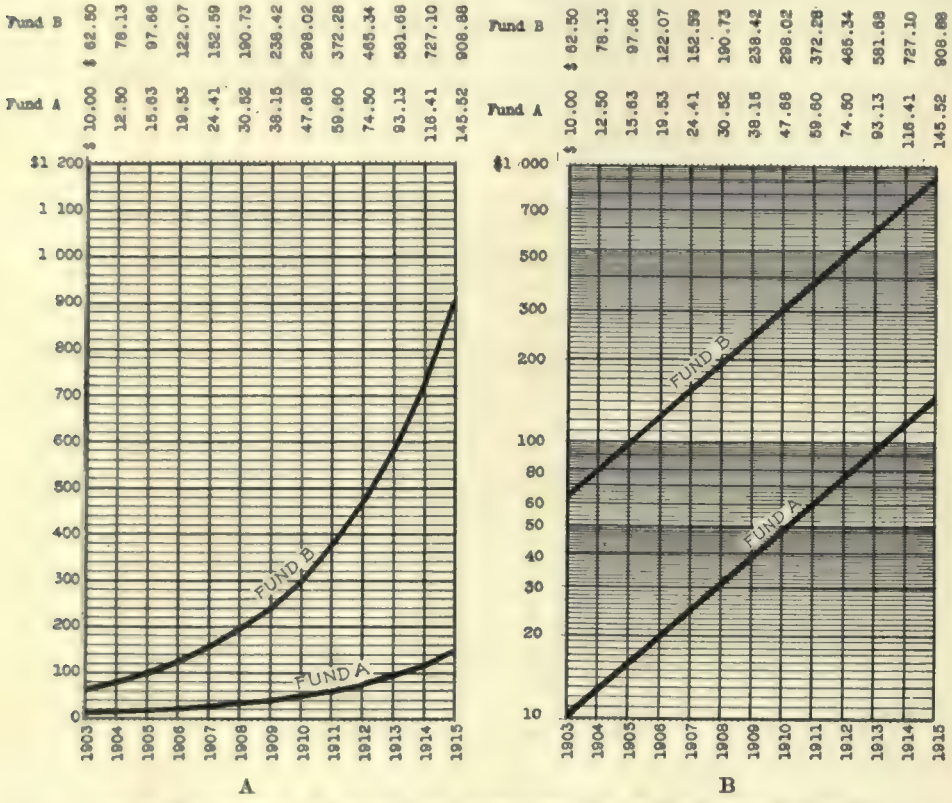


FIG. 1 COMPARISON OF CURVES ON ARITHMETIC AND ON LOGARITHMIC FIELDS

These two charts show how the same data look when plotted on different field rulings. Even the expert can not entirely avoid the feeling provoked by the arithmetical chart that Fund B increases at a faster rate than Fund A. The logarithmic chart avoids this difficulty, but it runs into others, making its use undesirable for management control except in special cases. The charts used in this figure were suggested by Mr. John Wenzel.

Although the present article is concerned with the comparability of curves plotted on arithmetic paper, nevertheless in passing it may be interesting to see how the above series looks when plotted on logarithmic paper. This has been done in Fig. 1-B. The straightness of the lines indicates that the rate of increase is uniform throughout, and the parallelism of the two lines shows that the rate is the same in both cases. Diagrams made on logarithmic paper, therefore, show the correct comparison of very small quantities with very large ones when drawn on the same field. In fact, one of the principal reasons for the existence of logarithmic paper is the unsatisfactoriness of ordinary co-ordinate paper as usually employed for showing the ratio between two or more curves plotted on it. But the many and irregular rulings of logarithmic paper bother the eye, and since a curve on logarithmic paper often takes a shape

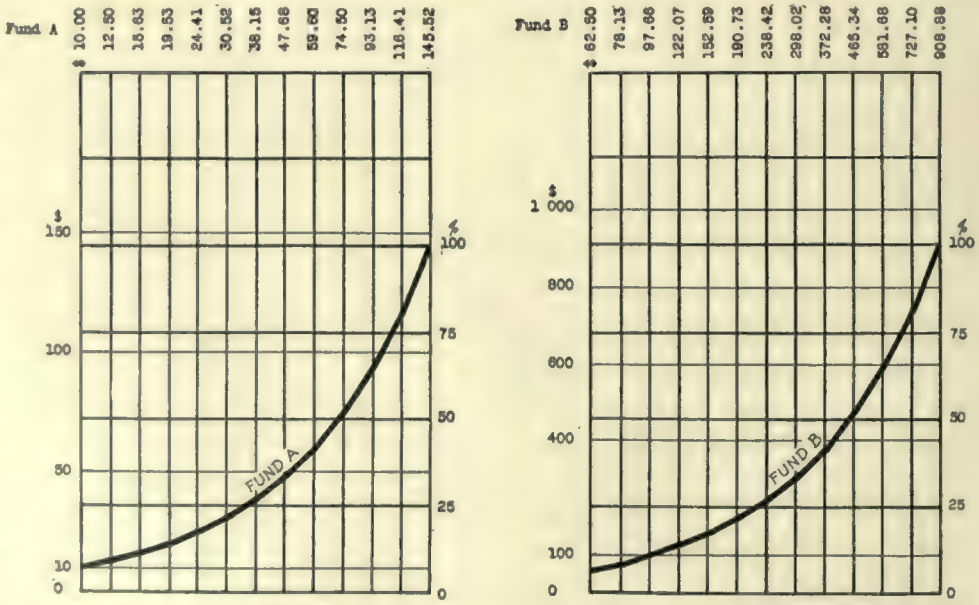


FIG. 2 COMPARISON OF CURVES ON THE ARITHMETIC FIELD, USING SCALE SELECTION

The same data have been plotted here as were used in Fig. 1, but the scales were chosen according to a definite principle. The result is a set of curves that are comparable as to rates, even though drawn on ordinary arithmetic paper. These charts retain the advantages of both the arithmetic and logarithmic fields.

so different from the one it assumes on ordinary co-ordinate paper, another element of confusion is added.

A noteworthy advance has been made with the establishment of the principle that curves are scientifically comparable when drawn on ordinary co-ordinate paper, provided they occupy a similar location on the chart field. With this principle and a set of scale selection tables for plotting curves according to the principle, the advantages of the logarithmic field may be enjoyed while retaining the advantages of arithmetic plotting. It is distinctly a gain to be able to compare one month's figures with those of another month absolutely on the individual chart, and at the same time to be able to make relative comparisons between different charts.

Referring again to Funds A and B of Fig. 1, we see in Fig. 2 how the curves appear when plotted in the new way, on separate sheets of arithmetic paper. In the two illustrations each chart has a percentage scale at the right, and a "natural" scale of dollars at the left. The curves can therefore be read in concrete dollars or in percentages. The scales have been chosen on the principle that rate comparisons are possible on arithmetic paper only when the curves to be compared are plotted at approximately the same distance above the zero line. In order to give the two curves in Fig. 2

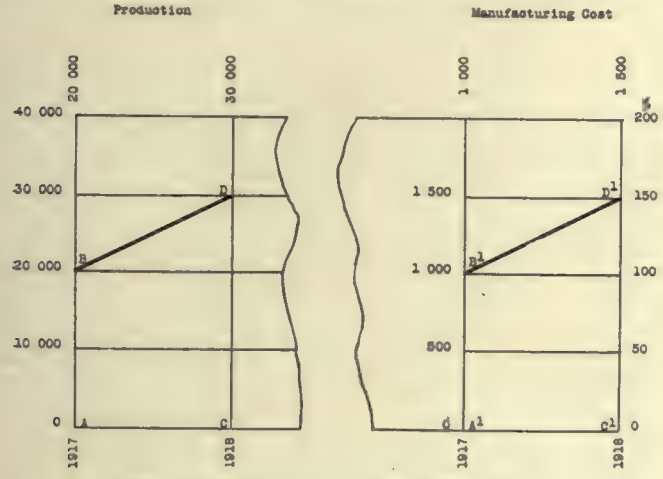


FIG. 3 IMPORTANCE OF THE ZERO LINE

A simple illustration to show the importance of the zero line. No error in graphic presentation is more common and more likely to produce serious consequences than the omission of the zero line. This applies to charts having arithmetic fields and to all cases where the actual distance of the curve above zero, and not merely the scale figures alone, is needed in order to give a correct visual idea of the size of the quantities.

similar locations on the fields, the respective totals \$145.52 and \$908.88 have been plotted at the same height above zero, and the intermediate values located proportionately to these totals. The plotting of any total at a uniform distance above zero and the location of the intermediate values have been reduced to a very simple process, easily mastered by the ordinary typist.

The test of this method of scale selection (which might be called the summation method, in contrast with the average or standard deviation method, familiar to statisticians, comes when we put one of these charts over the other so the zero lines and the vertical rulings coincide. When the originals of the charts illustrated in Fig. 2 were so placed it was seen that the curves representing Fund A and Fund B exactly coincided,

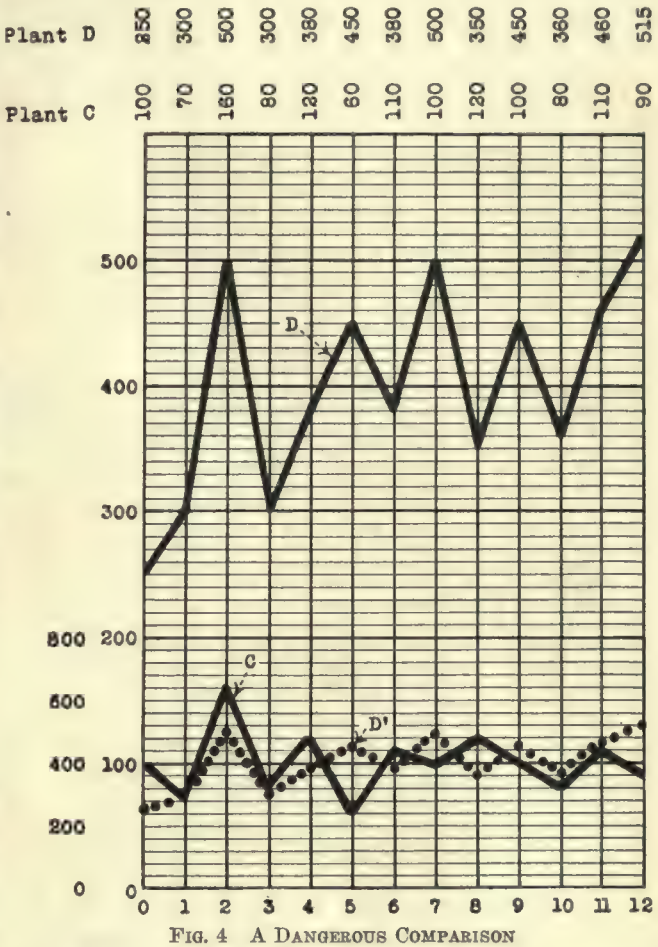


FIG. 4 A DANGEROUS COMPARISON

Both curves D and D′ are plotted from the same data and yet what a contrast in the visual impression! It makes a big difference, then, whether curve C is compared with curve D or with D′. Scientific scale selection prevents distortion of curves and establishes a visual impression always consistent with the facts, thus making it safe to use charts for the control of a business.

showing graphically what we already knew mathematically to be true, that the rate was the same in both cases.

IMPORTANCE OF THE ZERO LINE

Fig. 3 has been prepared to make clear another principle fundamental to the scientific comparison of curves. This figure contains parts of two charts, one representing production and the other representing manufacturing cost. In 1917 production stood at 20,000 units, and manufacturing cost at \$1000. The points representing, respectively, production and cost are plotted at the same distance above zero, and 100 on the percentage scale has been established at that same height.

In 1918 production had increased to 30,000 units and the cost of \$1500. Inspection of the curves connecting the plotted points shows them to be parallel, indicating graphically that the rate of increase is identical. By reading the percentage scale or by comparing the distance above the zero line the percentage increase is seen to be 50 per cent.

This illustration suggests how highly important it is to read curves by visually noting the distance above zero, which in turn emphasizes the necessity of always showing the zero line. Consider how the absence of the zero line would affect Fig. 3. Assuming that the horizontal rulings are 1 in. apart we could write down a "proportion," giving the relation of the values to the distances AB, CD, A'B', C'D':

2 in. : 3 in. : : 20,000 : 30,000

This would be a correct statement. But suppose in order to save space the chart had been cut off at the 10,000 line. The proportion would then read:

1 in. : 2 in. : : 20,000 : 30,000

This is patently incorrect.

The utter disregard for the zero line is the most serious fault of popular graphics. It is often observed in handsome and beautifully executed charts showing the fluctuation in stocks and commodities. Those who claim that the presence of the zero line is not necessary forget that in graphic methods the paramount thing is the visual impression. It is an appeal to the eye, and if the eye has to make adjustments and allowances, the purpose of graphic methods is largely defeated. Better stick exclusively to figures if charts cannot be made to tell true stories.

A chart-maker familiar with the principle that scientific relative comparability is only possible when the curves to be compared are located at approximately the same distance above zero will not be tempted to cut off his charts above the zero line. He appreciates, likewise, the use of the zero line in interpreting a chart constructed like the one in Fig. 4.

Here let us suppose that the general manager wished to compare the productive activity of his two plants. Since the two are to be compared, and since one is larger than the other, it seems natural to a chart-maker unfamiliar with the principles of scientific relative comparability, to plot both curves on the same scale, as is shown in Fig. 4. The manager glances at the chart, and impressed by the irregularity of curve D, he picks up the telephone and calling the superintendent of Plant D complains: "Smith, don't you know that irregular running means uneconomical running? Can't you do something to smooth things out at your place?" At the same time the manager might be inclined to praise the superintendent of Plant C for smoother running.

And yet if the manager took the trouble to read the curves by comparing the distances above zero he would see that the percentage changes shown by curve D are on the whole less than those shown by curve C. For example, between the first and second months C has more than doubled its height while D has not done so.

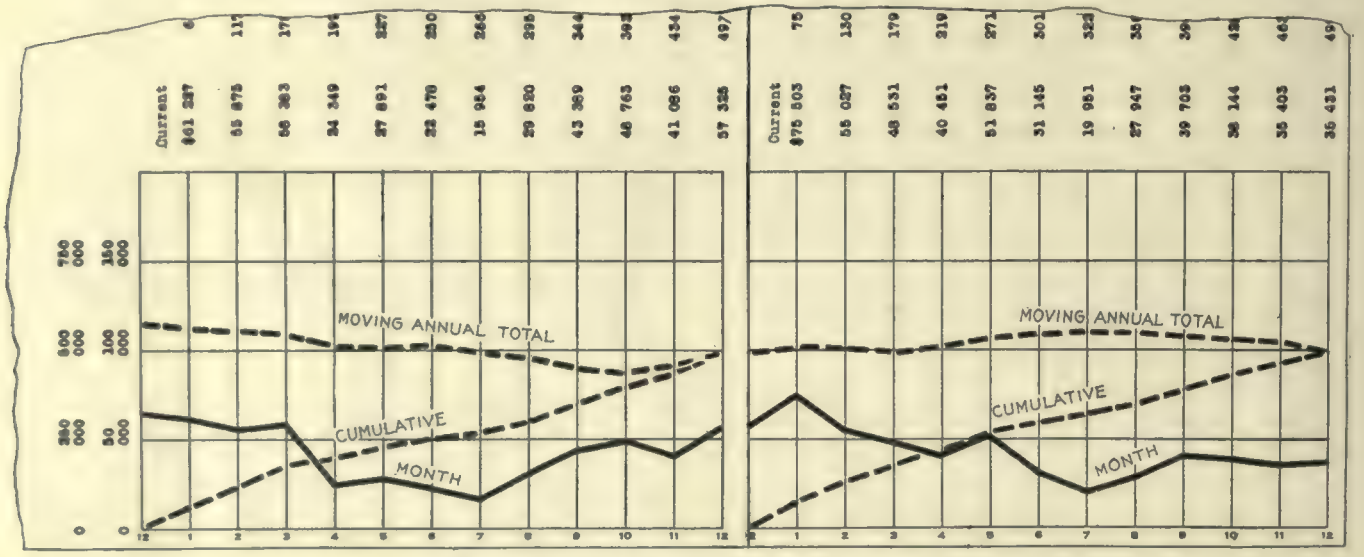


FIG. 5 HISTORICAL COMPARISON OF TWO Z CHARTS

The history of 24 months at a glance. The eye soon learns to watch the fluctuations of the curves in respect to the few horizontal field rulings. Note that the two years show very much the same amount of fluctuation, and that the second year would have exceeded the first if the current monthly curve had not failed to increase during the last four months.

To be sure, curves C and D as they stand show plainly the "ups" and "downs" of the business, but they do not show the correct comparison of the amount of fluctuation or irregularity unless they are read from zero and proper allowances are made.

But the manager cannot be expected to make the necessary mental adjustments in the distances. If he has to do so, the purpose of the graphic chart as a direct appeal to the eye is largely lost. D' is the upper curve replotted according to the new principle, and shows that as a matter of fact Plant D is running more smoothly than Plant C.

THREE WAYS TO COMPARE CHARTS

Standardized Z charts (the construction of which was described in detail in two previous articles)[2] are

[2] MANAGEMENT ENGINEERING, August, 1921, p. 83, and September, 1921, p. 153.

scientifically comparable because the scales are selected by means of a carefully worked out system, because a single subject only is plotted on one sheet, and because the zero line always appears. These charts may be compared in three ways:

1. *Historical Comparison.* By placing two charts for successive periods side by side as in Fig. 5 the trends of the curves and the average height of the curves may be easily compared. The narrow margins between the charts scarcely interrupt the continuity of the curves. If the charts are kept in books, one page can be made to overlap the next page for the purpose of making the historical comparison without removing the charts from the book.

This comparison furnishes a bird's-eye picture of the curves over a long period. It can be seen whether in spite of accidental or exceptional fluctuations the general trend is up or down. It is also possible to appraise quickly the amount of deviation shown by the curves or to pick out the exceptional peaks and valleys.

2. *Seasonal Comparison.* This is obtained by placing one chart above the other as in Fig. 6. In this comparison most attention is given to the current curves. The similarity between the two in Fig. 6 is at once apparent. The decline during the summer months is striking. The seasonal comparison is most often made between totals and their components, or between other closely related subjects such as production and unit cost, manufacturing cost and its components, materials, labor and overhead, sales and selling expense, total sales with the sales of individual salesmen, etc.

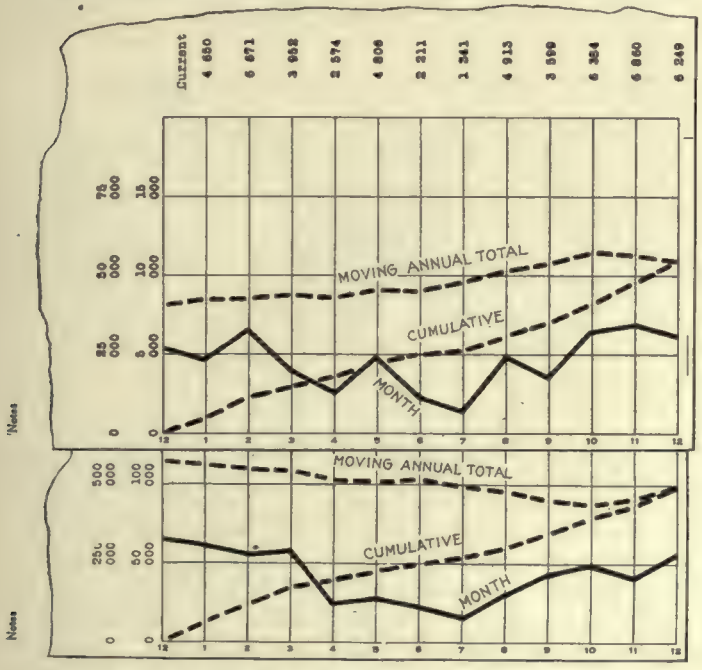


FIG. 6 SEASONAL COMPARISON OF TWO Z CHARTS

This is called the seasonal comparison because it is frequently made between charts showing successive years of the same subject. A similar comparison can be made, of course, between two or more comparable subjects of different kinds. The plotting of a single subject on a letter size sheet permits a wide range of comparisons, and does not limit the arrangement of the curves to a single combination as in Fig. 4. Note that the current monthly curves in both charts show the same general depression in the summer, while the moving annual total curves slope in opposite directions.

The lower chart in Fig. 6 represents total production, and above this total can be arranged the various departmental charts, only one of which is shown in the figure. It is easy to see that this department keeps fairly good pace with the total, but there are exceptional months. For example, the department increases much faster from July to August than does the total. The percentage increase of the department is about 250 per cent while the increase of the total is only about 85 per cent.

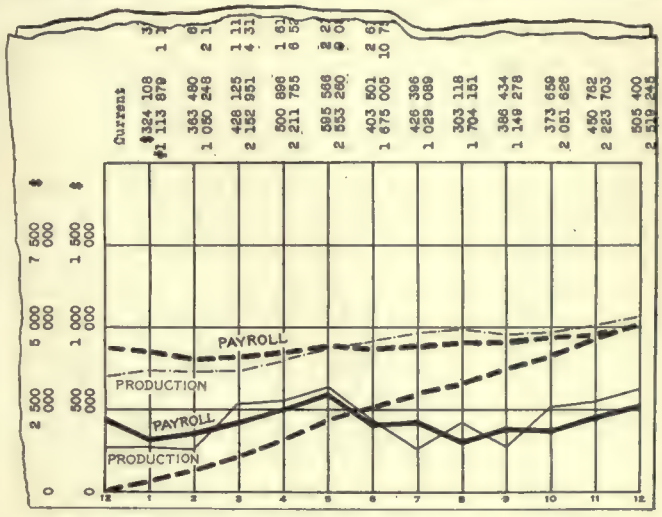


FIG. 7 ANALYTIC COMPARISON OF TWO Z CHARTS

This illustration is intended to suggest the effect produced when two Z charts are placed together and held against the light. The field rulings coincide. The heavy lines represent the curves nearest the observer. Only one cumulative curve is shown in the illustration. In the actual charts even the slightest variation between the two sets of curves can be easily detected. Note that the annual rate of production is increasing faster than pay-roll, i. e., more units of production are being turned out per $1 pay-roll. Variations in the two monthly curves are easily seen—for example, the inverse relation of these curves in July, August, and September is at once noted, but it might not have been seen by the accounting figures alone.

It would be an easy matter to compute and show graphically the percentages for all of the months and all the departments by noting the distances above zero. Such comparisons are highly important in cases where interdepartmental balance and uniform flow of production vitally affect the efficiency of the plant. Furthermore, the seasonal comparison instantly shows deviation from the general shape of the total curve. Why, for example, did the total go up in September, and the department fail to do so? In some industries the executives become so familiar with the shapes of certain curves that departures from the accustomed shape are quickly detected. In a certain motion-picture business the curve representing rental receipts of an individual film has such a sharply defined shape that standard or average curves can be drawn, by comparison with which it is determined whether a new picture is likely to yield good or poor results. One of the most important uses of charts is to provide

a quick and safe means of determining whether a given performance conforms to a predetermined standard.

3. *Analytic Comparison.* Place one Z chart over another so that the zero lines and the vertical rulings coincide, hold the two up against the light, and you observe the working of a very efficient graphic tool for the analysis of management data. The printed result of such a comparison is shown in Fig. 7. (The numbers marked thus "$," and the heavy curves, belong to the chart that is placed on top.) It will be noticed at once that although the amounts on the under chart are very much larger than the amounts on the other, the corresponding curves on both charts stand at about the same distance above zero.

The under chart in Fig. 7 represents production in pounds, while the upper chart represents pay-roll in dollars. Since the scales of the two charts are not the same we are not concerned with an absolute comparison, as would be shown by comparing the heights of the two curves above zero, but we are looking for the presence or absence of parallelism between corresponding curves. It is apparent at once that the two curves marked "Moving Annual Total" have the same general trend, showing graphically before numerical ratios are computed that the relation between production and pay-roll has remained fairly constant. A closer examination, of course, reveals slight variations during certain periods and shows that production is really increasing at a faster annual rate than is pay-roll.

To be sure, the same story could be told by figuring out the amount of pay-roll per unit of production or the amount of production per $100 wages, but, as was said in the beginning of this article, the superimposing of two charts is a quick means of getting at the facts before action is taken. Furthermore, comparable curves drawn on individual charts make possible a wide range of comparisons.

Materials, Handling in industry *658.54*

Handling Work on Machine Tools

By F. H. SWEET

MACHINE shops equipped with batteries of modern machine tools, representing a capital investment of thousands of dollars, are regularly losing a good-size proportion of dollars, are regularly losing a nomics for lack of intensive study of material handling. What is the advantage of saving 10 sec. on a milling operation when the workman has already wasted 10 min. in getting the job into the machine? Where is the saving effected by using a second head on a boring mill when a "helper" must be employed to assist in lifting fly-wheels or gear blanks on and off the face plate? The progressive manager can find many places around a machine shop where a few hundred dollars invested in devices to save moves can earn as much dividend as a much larger amount spent on the actual productive equipment.

Take the hack saw or cutting-off machine for example. A piece of round bar is to be cut up for turning and key-seating. The bar weighs 500 lb. Two men are told off by the foreman to get it from the stock rack and put it into the saw. It is heavy lifting, and the men feel entitled to stand and chat for a few minutes after the bar has been set up, leveled, and the saw put in motion. A length of I-beam hung from the roof, a trolley running on the lower flange, a chain-block suspended from the trolley, and one man can do the job unaided. The danger is lessened, fatigue is avoided, and one opportunity for a chat is eliminated.

Now let us take a look at the grinder. How seldom does one see a quick-acting hoist placed where it will assist the operator to hold a heavy piece steadily at just the right height and with just the right amount of pressure on the wheel. Yet the grinding machine can absorb more time, produce more rejected parts and cause more nasty accidents than almost any other tool in a machine shop. Think of the emery wheels burst through misuse, think of the fingers and arms damaged by the man slipping with an awkward shaped piece! With a chain-block conveniently hung, the casting is balanced so that the operation can be correctly performed, the work checked and re-checked as metal is progressively removed and time is saved because the operator has confidence in his equipment.

Hoisting Equipment for Lathe and Planer

A lathe is more commonly supplied with hoisting equipment than most of the other machine tools, perhaps because so many manufacturers have realized the time-economy on this machine tool resulting from the installation of proper handling devices. But the relative merits of a jib-crane, an overhead crane or a length of overhead track are not always sufficiently considered. The rig that is right for handling one job is not necessarily correct for another.

The planer is another tool which is often sadly neglected. Because it is a stately looking machine, with relatively slow, ponderous movements, is no reason why it should be allowed long seasons of rest between jobs. On the contrary, when the table is quickly unloaded and as quickly recharged, the percentage of saving is often a surprise as well as a delight to the manager.

In nearly all of these applications of mechanical hoisting equipment, an almost indispensable adjunct is a trolley with a short piece of track. The best form of track or runway is undoubtedly an I-beam, though two channels, back to back, will serve almost as well, provided that the bolts or rivets connecting them do not project so far as to interfere with the use of a standard trolley.

Standard 12 ft. lengths of track complete with hangers, end-steps, trolleys and lifting gears offer an easy solution to many a handling problem. The only additional equipment required is a suitable sling or bale, and even these accessories have been developed on thoroughly standardized lines. A well-designed grab or sling is like a giant hand; it takes hold instantly, grips the piece firmly and releases promptly.

Adequate handling facilities will not in themselves make money for the owner, but they will at least permit him to make more from his productive plant.

Inspection and Maintenance of Weighing Scales

By HERBERT T. WADE*

Physicist and Metrologist

TO secure efficient and accurate weighing in a manufacturing plant, the first step is to place on some special department or individual the duty of supervising the scales and controlling their use and maintenance. Whether this duty is handed over to a department or an individual, there should be no question of the responsibility involved and the relation of this work to the technical and production supervision of the plant. If the amount and nature of the weighing and equipment are not sufficient to warrant a special scale or weights-and-measures department, an outside service organization should be retained whose work should be overseen by an official selected for this duty. Moreover, this official should supervise the weighing throughout the works, making regular inspections in addition to the tests of the service people.

In a small plant this duty should not be either onerous or difficult for a competent technical man of the office staff, but if considerable weighing is to be done, the position will become increasingly important, amounting in a large and well-organized plant to the headship of a special and exclusive department of weights and measures. Ordinarily, however, the weighing equipment and practice could be supervised by one who gave from one-third to one-half his time to the work. Under such conditions a scale shop with one or more skilled mechanics should be maintained, and the requisite number of inspectors and helpers provided.

From the very beginning a regular routine of testing should be maintained with adequate records on convenient forms. A record of each individual weighing machine and set of counterpoise weights should be kept, giving their original cost, guaranteed capacity or accuracy, calibration or certification, if any, place of installation and nature of use, repairs when, where, and how made, reports of tests, and similar data. For such information appropriate cards or forms should be used, such as shown in Figs. 1, 2, and 8.

Given an inspection organization such as described, the next matter for consideration is its equipment, and this of course depends upon the nature of the plant, its size, and the character of the work done. It may be that a special building can be devoted to the weights and measures department, and this is advantageous in a large plant where much heavy weighing is to be done and where there is adequate crane service for moving test weights of large capacity to the scales, or for picking up the scales themselves and taking them to a scale shop. In a smaller plant the scale department, of course, would need but a room or two, depending upon the extent of the equipment and the amount of standard weights maintained. Tables,

Place ..... Owner ..... Mfr. ..... Date ..... Test No. ..... Page .....

Weather ..... Wind ..... Temperature .....

SCALE TEST RECORD
BUREAU OF STANDARDS
DEPARTMENT OF COMMERCE

Test Car No. .....
By .....

Obs.	Balance.	Op. Wt. on End of Beam.	Reading of Slider; Poise.	Equivalent Load on Beam.	LOAD. Position.	LOAD. Character.	LOAD. Value.	Error.	

FIG. 1 SCALE TEST RECORD AS USED BY THE U. S. BUREAU OF STANDARDS IN SCALE INSPECTION

A convenient form for use when testing platform scales of any capacity

Place ..... Owner ..... Mfr ..... Date ..... Test No. ..... Page ...

Owner's Identification ..... Maker's No. ..... Test By .....

Type of Scale .....

Capacity, Sliding Poises .....x.....lb. : Foundations .....

Capacity, Ctp. Weights .....x.....lb. : Accessibility .....

Nominal Capacity .....lb. : Material of Platform .....

Leverage Ratio ..... : Size of Platform .....

Use .....

History .....

Condition of Parts .....

.....

.....

Counterpoise Weights: Identification	Equivalent Value	Actual Value	Error: gr.	Tolerance: gr.	w.t.	o.t.	SUMMARY OF TEST
							Test No. .....
							Type .....
							Identification .....
							Capacity .....
							Condition .....
							Error .....
							s.r. .....
							Ctp. wts. .....

FIG. 2 FORM FOR RECORDING SCALE DATA AS USED BY U. S. BUREAU OF STANDARDS

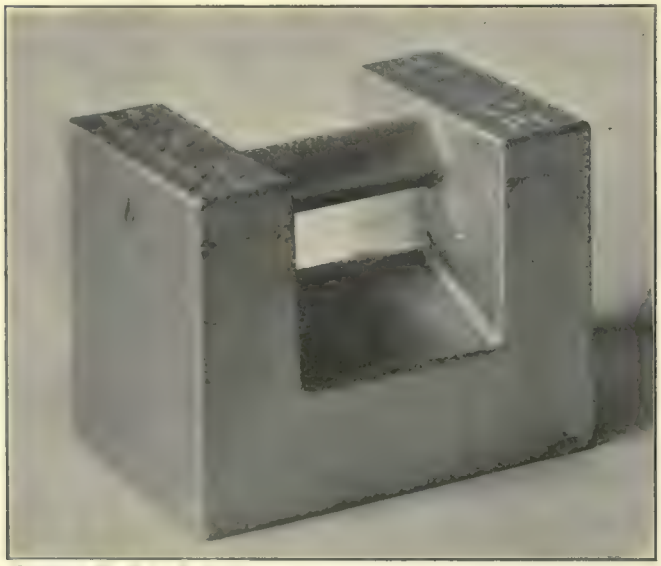
With modifications this inspection record could be employed in industrial plants.

* Mr. Wade was for a number of years a member of the staff of the Department of Physics of Columbia University, and has devoted himself to technical and industrial research, especially in the field of metrology. With the late Prof. Wm. Hallock, he is the author of a standard treatise, "Evolution of Weights and Measures and the Metric System," and later prepared a large number of papers and articles published in the engineering and general press dealing with metrology, industrial weighing, and especially track scales. During the war Mr. Wade, with the rank of captain in the Ordnance Department, U. S. A., was in charge of the Special Report Branch of the Information Section of the Office of the Chief of Ordnance. He is, and for many years has been, technical editor of the New International Encyclopaedia and technical and scientific editor of the series of New International Year Books.

brackets, or pedestals reasonably free from vibration should be provided upon which the scales used in comparing the counterpoise and test weights could be installed. Usually such facilities are provided in the scaleman's office, which should be independent of the shop where repairs are executed. The size and equipment of the machine shop for scale repairs naturally depend upon the amount and character of the repairs, and whether most of the heavier work is done in the plant or sent to scale manufacturers.

Of course the most necessary feature of the testing equipment is an adequate supply of heavy standard weights. The usual size is 50 lb., and the usual material is cast-iron painted or lacquered with hard paint or enamel, the type and form recommended by the United States Bureau of Standards being shown in Fig. 3. If there are such facilities for handling as overhead cranes, 500 lb. standard weights can be used with advantage and will save much time in making heavy capacity tests, at least 10 50-lb. and 10 500-lb. weights affording a sufficient amount for ordinary testing.

Fifty-lb. standard test weights of sufficient accuracy for ordinary purposes can be easily obtained, but they are liable to change with wear and use. Consequently where there is much of this heavy testing to be done, it is desirable that the plant should possess reference standard weights of an accuracy corresponding to the specifications of "Class C"[1] of the National Bureau of Standards, and a bullion or other good even arm balance of precision for the testing of the working standards. A common type of even arm balance supplied for this purpose and capable of supporting a weight



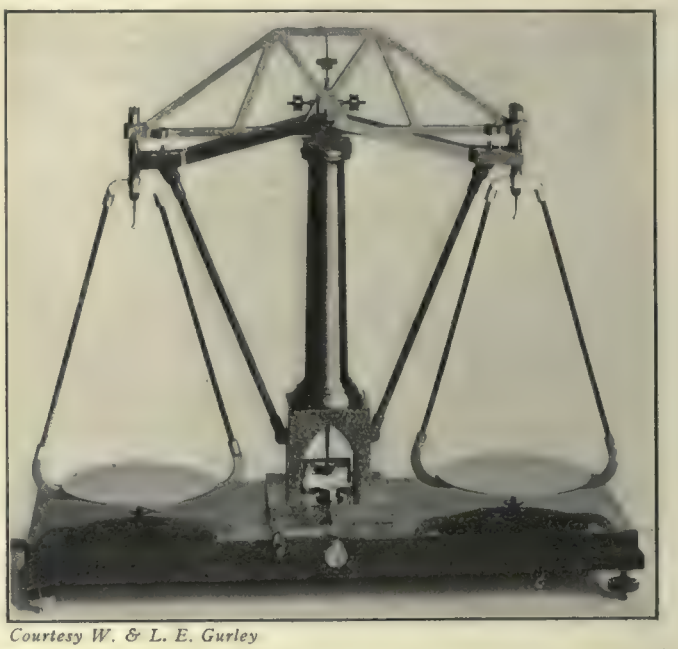
Courtesy W. & L. E. Gurley

FIG. 3 FIFTY-POUND CAST-IRON STANDARD TEST WEIGHT FOR TESTING SCALES

Note the sealing cap on the left side.

of 50 lb. in each pan, has a sensitiveness of 1 grain or 0.06 gram at full capacity (Fig. 4). Comparison of the heavier standard weights for this purpose, however, can be done with high accuracy on almost any reasonably sensitive scale or capacity balance by the method of substitution, where the weight to be tested is substituted for the standard or standards and the excess or deficiency determined.

It is also desirable to have standard counterpoise weights which are correct within the "Class C" toler-



Courtesy W. & L. E. Gurley

FIG. 4 HEAVY CAPACITY PRECISION BALANCE FOR COMPARING 50-LB. TEST WEIGHTS WITH STANDARDS

ance, for if the counterpoise weights of the scale are employed in the test their errors must be ascertained by comparison with standard weights, and the corrected, not the nominal, values used in computing the errors of the scale. A convenient arrangement is a set of standard slotted hanger weights made in accordance with the specifications developed by the United States Bureau of Standards and of course within the tolerance limits of "Class C" weights, so that test can be made of the multiplying power of the scale by suspending them at the end of the beam and balancing them against the heavy standards on the platform. There should be also a set of grain weights, 20 grains to 0.5 grain, which can be used in connection with the counterpoise weights and for other purposes where slight differences are involved.

For testing the counterpoise weights at the different scales a sealer's balance, a portable even arm scale used by weights and measures inspectors, of a capacity of 10 lb. in each pan, should be available (Fig. 5). At full load this has a sensibility reciprocal of one grain which is adequate for the ordinary testing of working counterpoise weights against standards.

The ordinary and reasonable standard of accuracy to be maintained for scales in an industrial plant is that required by the specifications and tolerances adopted by the Eleventh Annual Conference on Weights and Measures of the United States (1916) and accepted by the Bureau of Standards.[2]

[1] Circular of the Bureau of Standards No. 3, "Design and Test of Standards of Mass," gives specifications and tolerances for standards and counterweights of the different classes of accuracy prescribed.

[2] Available as Bureau of Standards Circular No. 61, "Specifications and Tolerances for Weights and Measures and Weighing and Measuring Devices."

Certain scales in a plant may fail to meet the requirements here stated, and these can be used temporarily for unimportant weighing that does not need to be exact. But attention should be called to this condi-

Courtesy W. & L. E. Gurley

FIG. 5 COMBINATION SET OF TEST WEIGHTS, 10 LB. TO 1/16 OZ. Adjusted to "Class C" accuracy these form convenient reference standards for a plant.

tion both in the office records and by placards posted on the scales themselves stating that they are to be used only for certain specified purposes and are not to be employed where accurate weighing is required.

It is also essential to mark every scale in a plant with its nominal capacity, beyond this it should never be loaded, not only on account of the possible damage to the scale but on account of the inaccurate weights an overloaded scale may return. Likewise the counterpoise weights belonging to a certain scale should be so designated by appropriate marking, and workmen should be prohibited from interchanging weights between different scales. Furthermore, care should be taken to see that full sets of correct weights are always provided at each scale. Obviously the correct reading of the scale depends upon the correct counterpoise weights, and by the use of a wrong set with incorrect ratio for a given scale large errors may result. To prevent such occurrences is one of the many duties naturally falling to the scale department and its inspectors.

It is the function of the scale department to require that scales and weights are kept clean, oiled, and in good order generally, especially in such service as in the paint department, where paint or foreign materials are likely to be deposited on the weights or operating parts, or in the weighing of corroding chemicals, in which case the scales must be watched to determine when they are so attacked as to require replacement. Of course the scale inspectors should see that all scales are kept firm and on a level surface and in favorable positions as regards light and convenience of access.

The interval between tests is a matter to be considered in the light of individual circumstances in different plants. Complete tests of all scales should be made every six months, while the more important scales should undergo a similar complete test at least every three months or perhaps oftener, not to mention frequent service tests and inspections.

The ordinary commercial or routine test of a scale for accuracy, is merely to determine whether the errors are within certain acceptable or approved limits appropriate to its type and conditions of service, in other words, a tolerance test. As the errors of the scale may vary with the amount of load and its position on the platform it is usual to place the standard weights in varying amounts and at different positions on the platform successively so that their sum may be compared with the weight indication in each instance.

Previous to the actual test, however, there should be a preliminary examination, the platform being removed to ascertain that all parts and weights are intact

Courtesy W. & L. E. Gurley

FIG. 6 SEALER'S PORTABLE BALANCES FOR TESTING COUNTERPOISE WEIGHTS

and that the levers are free in their movements. Of course the housing of the levers, or the pit, should be clean, and all dirt and foreign matter that might prevent free motion removed. It would seem unnecessary

to speak of so elemental a condition as ordinary cleanliness, were it not that cleanliness is frequently conspicuous by its absence, and of course it is useless for an inspector to go further until this is remedied. Then there should be an examination of knife-edges, bearings, check rods, anchor points, and foundations generally. Such preliminary examination will reveal whether check rods bind, whether the knife-edges are

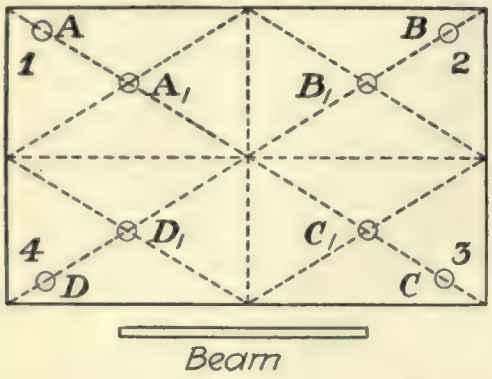


FIG. 7 DIAGRAM TO SHOW POSITIONS OF TEST LOADING OF A SCALE PLATFORM

The method of numbering the corners is recommended as standard practice by the Bureau of Standards.

rusted, worn, or broken, and whether the operating parts are so jammed with dust and foreign material that free motion is hindered. If the knife-edges are badly flattened by wear or rusted there is nothing to be gained by proceeding with the test until the levers have been removed and the knife-edges replaced and refinished. This work cannot be done by an ordinary blacksmith, but only by a competent scale mechanic, and it must be realized that upon the proper position of the knife-edges depends the correct reading of the scale.

Obviously no moving parts of the scale should touch or rub against the frame or other rigid or permanent structure, and all loops and connecting rods must be plumb and vertical. The knife-edges should rest centered and uniformly on their appropriate bearings, and the various check rods, whose function is to keep the platform in its proper position as regards knife-edges and bearings and protect them against jar and impact, should be intact and rest free and loose in a horizontal plane on their pins or other supports.

Once the conditions stated are met the actual testing can be begun, and this may be conveniently divided into six stages as follows:

1. The levers beneath the platform are tested for uniformity in their multiplying power, or the ratio of the lever arms.
2. The poise weights are tested on a sensitive balance against accurate test weights.
3. A graduated test is made of the scale from zero to full load with standard test weights.
4. The sensitiveness of the scale and the sensibility reciprocal are determined in the course of the preceding tests.
5. The constancy of the scale or its ability to repeat at or about full load is also determined while the test weights are placed on and off the platform.
6. The accuracy of the poise beam or beams as regards its division also is tested.

The first actual step in the test of a platform scale is to see that it balances at zero load, that is, when the sliding poise or poises are set back to zero and all the movable counterpoise weights are removed. If out of balance, the scale is balanced either by the balance ball or by removing or adding, as necessary, the loose shot contained in the counterweight pan. The first test with the test weights is to place them at the center of the platform in an amount about equal to one-fourth the capacity of the scale. If available, the standard counterpoise weights already referred to should be used in making the reading, unless it is a full capacity beam, when, after balance is secured, the readings should be made with the sliding poise or poises if there are one or more auxiliary beams.

The next step is to determine the sensibility reciprocal and thus ascertain whether the scale is sufficiently sensitive for the work in hand. Then the test weights should be placed successively at each of the four corners, 1, 2, 3, 4, directly over the principal platform bearings, A, B, C, D, as indicated in Fig. 7, or, if this is not feasible, with their center of gravity at each of the small circles A_1, B_1, C_1, D_1, as designated. The object of this is to show whether each lever of the system has the same ratio of arms or multiplication.

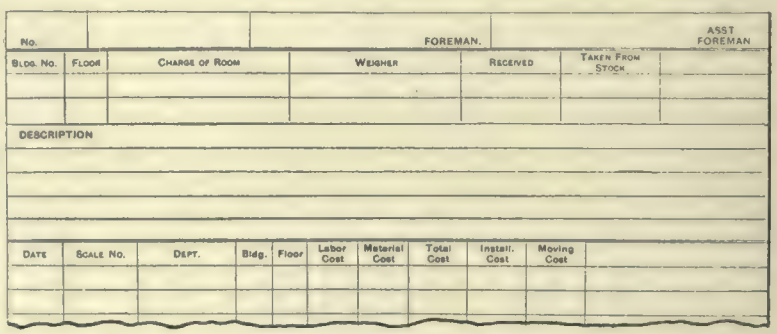


FIG. 8 FORM CARD RECORD OF INDIVIDUAL SCALE USED BY THE SCOVILL MANUFACTURING COMPANY

A usual requirement of all platform scales, except track scales, is that when a load of test weights representing one-half or more than one-half the capacity of the scale, and not exceeding such capacity, is placed so that its center of gravity lies over the points designated by circles A_1, B_1, C_1, D_1, in the diagram, the error at each point shall not exceed the tolerance allowed for the load employed, such tolerance being specified in tables published by the Bureau of Standards, and generally accepted. If a load equal to one-quarter of the capacity is used, it should be placed so that its center of gravity lies directly over the platform bearings A_1, B_1, C_1, D_1 as shown in Fig. 7, and the

errors should not exceed those previously indicated.

The last stage is the full capacity test and the determination of the sensibility reciprocal for that loading. It is also desirable to test the graduation of the beam for the sliding poise or poises, though these are likely to be satisfactory with the best grade of scales. As showing the importance of the matter it may be said that in some large capacity track scales a movement of 0.16 in. of the main poise is equivalent to a load of 1000 lb., so that an error of 1/100 of an inch in the position of the main poise would correspond to 62.5 lb.

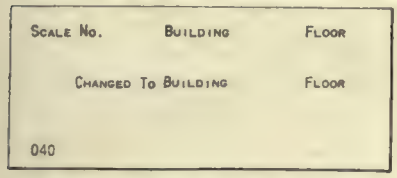


FIG. 9 SCALE TRANSFER FORM AS USED BY SCOVILL MANUFACTURING COMPANY

Obviously what has just been said applies to platform scales of the beam type, though a similar procedure would be followed for other scales, including automatic dial scales. With a dial scale the test weights would be placed on the platform in the same manner and in the same positions as described and the appropriate readings with different loadings noted. With no load the pointer of course should stand at zero, and after a loading is removed it should return to that mark promptly. Inasmuch as the lever system of a dial scale is essentially the same as that of a beam scale, the application of the standard weights to the platform establishes the same conditions of test, and the same accuracy should be secured as with beam scales.

While most dial scales are more recent in type and, being more delicate, are maintained with greater care than beam scales, nevertheless they require the same careful and frequent tests. In addition to the fundamentals of the levers, dial scales have also special features appropriate to the indicating mechanism, which is of fine and delicate construction and adjustment.

With automatic scales proper the testing, of course, is a most important function, for unless the apparatus is able to deliver its successive drafts of the required accuracy the operation fails of its object, for precision no less than speed and convenience is essential to such automatic machinery.

The scale having been thus tested and the appropriate record made, after making whatever corrections and allowances are required, it is possible to judge of its accuracy and suitability for the work in hand by referring to the table which was among those adopted at the Eleventh Annual National Conference of Weights and Measures held at the Bureau of Standards, Washington, in 1916. If the accuracy of the scale as determined by test falls within the limits of the table, then it probably will suffice for ordinary weighing of a plain commodity. But there are of course different conditions which each works manager must realize and develop for himself. He must set the tolerances and accuracy that apply, and the scale department providing the equipment and in its maintenance must meet the scale of tolerance that is decided on. This is not an impossible task although it may involve outlay, for today commercial weighing scales of any desired accuracy and convenience can be obtained, of course at a price, so that it is the duty of the industrial engineer to decide what degree of accuracy must be secured.

AN EFFICIENT SCALE INSPECTION DEPARTMENT

Within the last quarter of a century efficient scale departments have been developed in a number of the better organized American railways and in some of the larger industrial plants, especially in the steel industry. Similar work has been done in other industries, but in particular a most thorough organization with satisfactory results has been achieved by the Scovill Manufacturing Company at Waterbury, Conn. In this large plant, which manufactures brass and articles made from brass, a scale department has charge of more than 800 scales, ranging in capacity from one ten-thousandth of a pound to several tons. As early as 1911 this company, realizing the importance of accurate weights and measures and securing their use, organized a section of its tool and machinery department to maintain and inspect scales and weighing machines and also to look after the physical measuring machines, measuring pumps, and similar devices in a large plant where precision of measurement or ordinary determination of sizes and quantities enters.

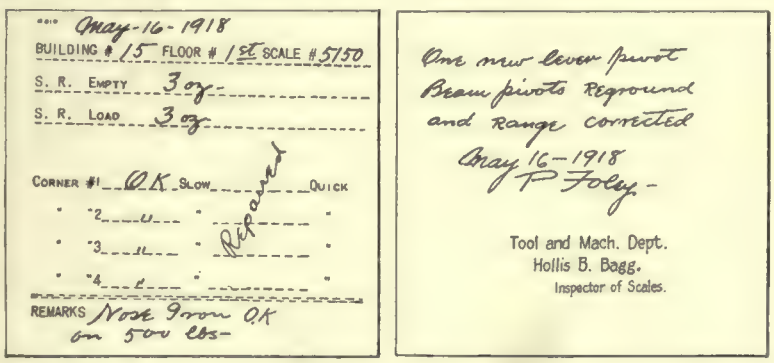


FIG. 10 SCALE REPAIR RECORD TICKET AS USED BY SCOVILL MANUFACTURING COMPANY

This form is filled out after the needed repairs have been made and the scale has been tested.

This work has been developed under the supervision of Hollis B. Bagg, who bears the title of Scale Inspector, and the department has achieved so wide a reputation in its field that an outline summary of its scope and activity should be of interest. Every scale in the plant is numbered and is represented by an appropriate card (Fig. 8) on which is inscribed the scale number, building number, floor number and department, description of the scale, and other data, as indicated on the reproduction herewith. Any change of a scale to another building, floor, or department is accomplished by a man from the scale department, thus

insuring that the work is done with care and that the scale when moved is set up in proper shape for use. The man who does the moving fills out a card (Fig. 9) giving the date and particulars of the transfer, signing his name to it. This card is then given to the scale inspector and the record is changed.

Regular intervals for inspection are prescribed for all scales, ranging from a daily test for those in the packing rooms and shipping departments to less frequent tests for those not so likely to show small variations. For every scale tested a printed test ticket is filled out to be filed as a record, except in the case of a scale found in need of repairs, in which case the man who makes the repairs fills out the ticket. If a scale fails to pass inspection tests, or if the sensibility reciprocal of the beam equals or exceeds the minimum graduation, the inspector at once attaches to the scale an "Out of Order" tag, a duplicate of which goes to the chief inspector, who then sends a repair man. The repair man after making his repairs fills out a repair ticket (Fig. 10) with the word "Repaired" written across the face and notes on the back the nature and extent of the repairs, the date and his signature, giving the ticket to the chief inspector to be filed.

The scale department at this plant also carries on an important and valuable educational work to demonstrate the proper use of the scales to secure accuracy. It obtains the names and check numbers of workers in each department who use the scales, and then holds a series of classes comprising the foreman and those workers who weigh for any purpose. These classes are held in the scale department and the attendance and proficiency of each man are determined. Thus it is easy to find out when a workman is habitually careless or is incapable of making a careful weighing.

The assistant scale inspectors inspect each scale in the plant once each day, and on finding a scale out of repair they telephone the scale department and place a red tag on the scale. A daily report is made of the number of scales inspected, the number out of order, abuse of scales, and any other essential matters.

From the daily records of the scale inspectors a condensed weekly report is made which is given to and considered by the scale committee of the plant, made up of heads of departments or others specially concerned in weighing matters. The department also compiles an accurate record of the cost of repairs of each scale, which is kept according to the shop number of each scale and the department in which it is used. The records of the scales thus give an adequate history of their use and performance, so that the entire question of weighing as well as individual items of equipment can be handled with knowledge and intelligence.

SCALE SERVICE ORGANIZATIONS

The service departments now maintained by the leading American scale companies at their principal branches have developed to a point where they have become an important consideration for the customer or client, whether he uses scales frequently or not. These departments afford an outside and independent inspection of the scales and look after their proper care and maintenance, not to mention their periodic test with standard weights under service conditions. The plant managers are thus kept constantly in touch with competent scale men and their weighing concerns are presented to them in a proper light and in the proper proportions, for the scale inspector is able to report not vaguely but in terms of pounds and percentages. Such a service is quite as desirable as having an independent audit or periodic examinations made of the books of a company by outside accountants, for in the field of weighing, however good the equipment may be, it is advisable to have independent experts make periodic inspections and tests.

In many cases the service includes maintaining the scales in good order and adjustment, so that for a small plant which is not large enough to justify a scale department or even a single scale mechanic this side of the work is well taken care of and the scales are always kept in good condition. In many cases the service contracts call for visits once a month or on call so as to check up plant scale inspectors and mechanics. At such plants it is required that heavy test weights in adequate amount be maintained so that the visiting inspector can investigate conditions with a minimum of time and without the trouble and expense involved in the transportation of large amounts of such weights.

This service supervision is also good for the scale companies, in that it enables them to keep track of the performance of their scales in service, so that they can appreciate their good points and also the various defects developed by use. For the client it affords a reasonable guarantee of the accuracy of his weighing apparatus, and the periodic inspections and reports serve to stimulate interest in scales and weighing.

RULES FOR THE USE OF SCALES

SCALES MUST BE KEPT CLEAN, FREE FROM OIL AND DUST. CLEAN THEM OFTEN WITH CLEAN WASTE OR A CLEAN CLOTH. SCALES MUST BE KEPT IN BALANCE.

PLATFORM SCALES REQUIRE TO BE BALANCED OFTEN. IF ACCURATE WEIGHTS ARE DESIRED THEY SHOULD BE BALANCED BEFORE EACH LOAD IS WEIGHED.

THE BEAM ON ALL PLATFORM SCALES MUST BE LOCKED AND REMAIN LOCKED EXCEPT DURING THE ACTUAL TIME OF WEIGHING.

DO NOT ALLOW WORK TO REMAIN ON SCALES LONGER THAN THE TIME IT TAKES TO WEIGH IT.

DO NOT LOAD A SCALE BEYOND ITS CAPACITY; IF IT IS 600 LB. SCALE, NEVER WEIGH OVER 600 LBS.; IF 1000 LBS., NEVER WEIGH OVER 1000 LBS.

NEVER MOVE A SCALE WHEN THERE IS A LOAD ON THE PLATFORM. THEY ARE NOT INTENDED TO BE USED AS TRUCKS, AND WILL NOT WEIGH CORRECTLY IF USED AS SUCH.

DO NOT THROW OR DROP WORK ON THE PLATFORM OF ANY SCALE; IF YOU DO, THE SCALE WILL NOT WEIGH CORRECTLY AND YOU MAY BREAK THE PIVOTS OR LEVERS.

WHEN YOU MOVE A PORTABLE PLATFORM SCALE SEE THAT IT SETS LEVEL. IF THE FOUR WHEELS DO NOT SET FIRMLY ON THE FLOOR, OR THERE IS ANY ROCK TO THE PLATFORM, THE SCALE WILL NOT WEIGH CORRECTLY.

JITNEYS AND TRUCKS SHOULD NOT BE ALLOWED TO PASS OVER SCALES.

TREAT YOUR SCALES RIGHT AND THEY WILL GIVE YOU HONEST WEIGHTS; ABUSE THEM AND THEY WILL LIE TO YOU.

NO CHANGE, ALTERATIONS, OR REPAIRS WILL BE ALLOWED TO BE MADE ON ANY SCALE EXCEPT BY THE SCALE INSPECTOR OR HIS ASSISTANTS.

IF THE SCALES NEED ATTENTION, TELEPHONE THE SCALE INSPECTOR.

ALL SCALES ARE NUMBERED AND ARE LOCATED BY THIS NUMBER IN DEPARTMENT, BUILDING, FLOOR AND ROOM. IF YOU DESIRE TO CHANGE SCALES PERMANENTLY FROM ONE ROOM TO ANOTHER, NOTIFY THE SCALE INSPECTOR, AND IT WILL RECEIVE HIS PROMPT ATTENTION.

THIS IS NECESSARY IN ORDER THAT SCALES MAY BE TESTED AND RECORD CHANGED.

RULES ATTACHED TO EACH SCALE AT SCOVILL MANUFACTURING COMPANY PLANT

Industrial Democracy in Great Britain

Success Will Come From Faith in the Experiment and a Recognition of the Fundamental Honesty of Men

By CLARENCE H. NORTHCOTT*

Wages Section, Rowntree & Company

IT is becoming more and more recognized that the great problem of industry today is a permanent improvement in the relations between employers and workmen. Wherever industry is at all developed, its continuity and progress suffer from sporadic disturbances of the machinery of industrial relations; no country being free from this unparalleled hindrance to efficiency. Whatever general type of labor policy may be adopted it seems to afford no great measure of relief.

Australia, for instance, where unions have unrestricted access to courts of arbitration whose awards are legally binding upon employers, has an unenviable record of industrial trouble. Great Britain, too, where the large increase in union membership has given trade unionists greater economic weight in the usual voluntary negotiations, falls nothing short of her great daughter Dominion in her record of strikes. And America where the open-shop policy aims at getting ahead of the unions in the effort for better conditions, cannot escape the strike fever. Hence it would seem that some more fundamental labor policy than that involved in the dispute between the open and the closed shop must be undertaken if better relations are to obtain.

A Policy of Face-to-Face Dealing

This better policy must involve at least straight face-to-face dealing with workers in the shop. Not as individuals, however, but as representatives of their fellows must the workers be received. For there is something enlarging and, indeed, ennobling in the position of the representative. He tends to speak the better thought of his fellows rather than his own, and to think a little above the average of the public opinion of the workroom. On the other hand, he sees sides of the management that he had never imagined, and is thereby enabled to take back a truer report of actual conditions. If his grievance has been against a foreman or an under-administrator and is met by absolute justice from the higher heads, a whole tide of friendly co-operation is set moving that will sweep away many misunderstandings.

Several illustrations of this type of industrial democracy have come under the writer's notice in Great Britain. As one familiar with the strength of trade unionism in that country would expect, most trade unions carefully guard their own customs. This practice, however, by no means impairs the spirit and essence of the works councils about to be described. These councils are set up "to encourage and establish good relations between workers and management," and the larger part of their activities have to do with conditions that concern only the particular shop. Such a scheme is that in existence for many years in the works of Messrs. Cadbury Brothers.

The Establishment of a Works Council

The first steps taken by this firm to get into friendly relations with the workers date from early in the century when various small committees were established to deal with certain parts of the workers' welfare. Later, when a pension fund was established, the administration of the fund was intrusted to a committee on which the workers were represented. Eleven years ago a suggestion committee was established, consisting entirely of elected representatives of the workers. The constitution of the works council now in existence was framed by a committee composed of an equal number of members selected by the management and by the workers which sat for a year. It is thus the culmination of a series of efforts to get into human, effective touch with the 8000 workers in this factory, so as to obtain their vital co-operation.

In the formulation of a scheme of industrial democracy for so large a plant, Messrs. Cadbury Brothers have set up separate councils for men and women respectively. Within each of these, which have equal powers on their respective sides, there is a threefold scheme of representation for the workers.

The first element in the scheme is the election of a committee within each shop or section under a departmental manager or foreman. Next, the whole works have been divided into groups, eight in number, and each shop committee included in a group elects one representative to what is called a group committee. Finally, for each group there is elected by the whole of the workers in that group one representative to sit on the works council. Thus the interests of the workers are adequately represented in strict accordance with democratic custom, yet with due regard for the prevention of overlapping or the overloading of the representative machinery.

* Mr. Northcott has had an international experience in industry and with labor. He came to the United States from Australia during the war, filled several positions that brought him in contact with American labor, and for some time was investigator and statistician for the National Industrial Conference Board. Some two years ago he went to England to continue his investigations and work, and is now connected with one of the large British industries.

This interlinking is of even greater value when regarded from the top down. The decisions of the works councils are carried back to each group committee and explained by those who have taken part in them. The members of the group committees, equipped with full knowledge of these decisions and of the reasons which prompted them, can, in their turn, meet the shop committees, and, through them, the rank and file. The system offers the employee both the right and the opportunity to have grievances redressed and to take his or her part in improving conditions; it affords also a means of allaying suspicion of motives and ignorance of the company's policy. This is its crowning merit and the secret of its success.

Of course, these committees are joint, in the sense that they comprise representatives of both the workers and the management. A shop committee may consist, in the case of men and women alike, of a minimum of three and a maximum of twelve workers with a representation on the part of the firm of not more than half the number of the firm's representatives. The group committees are exclusively workers, formed as a link between the shop committee and the works council. The works council is a joint body consisting of eight representatives of the firm as well as of eight workers. Of the former, four members in the case of men and five in the case of the women are nominated by the firm, the other administrative representatives being elected from the clerical and supervisory staff.

Qualifications for Membership and Voting

The qualifications for voting and membership are of interest. Every full-time worker of either sex who has attained the age of 16 years may vote in the election of representatives on a shop committee. For membership on a committee, however, five years' service with the firm and a minimum age of 21 and 20 years for men and women respectively are required. A workers' representative on the works council must not merely be a member of a group committee, but must be, or have been, a member of a shop committee. These provisions place a certain premium on the sense of public service and on moderation and responsibility. In general, however, persons are elected of moderate views and with a fair sense of the opportunities afforded by the system, though occasionally a militant representative gets in and puts some "ginger" into the proceedings.

All representatives chosen in an election must have received an absolute majority of the votes cast. On shop committees representatives retire annually, but may be recalled during the period for which they have been elected, on proper representations and resolutions. In the case of the works council one-half of each side retires annually but are eligible to be returned again. A workers' representative, however, may not serve more than two periods, that is, three or four years, without standing aside for a period of at least a year in the case of men and two years in the case of women. These two last provisions insure continuity in the policy and personnel of the council without making membership of it a closed monopoly open only to those who secured the first seats.

The subjects with which the shop committees may deal include the health of employees, cleanliness and tidiness of shop and lavatories, good timekeeping and discipline, investigation of grievances, prevention of waste, increasing the interest of men in their work and in the output of the whole shop, promotion of efficiency of employees and plant by study of processes and technique, "safety first," consideration of new and altered processes and their effect upon the shop, education, wages, and so forth. No executive power, however, is possessed by these shop committees except through the management. In the case of the works council, its powers form the subject of delegation from the board of directors, to whom alone the council is subject and responsible.

How the Council Is Organized

In the councils each side elects a chairman and vice-chairman. The management and workers' chairman or vice-chairman take turns in presiding at council meetings. Each side may also appoint a secretary from outside the membership of the council, and each secretary may take part in the proceedings, but without a vote. Accommodation and stationery for both secretaries are provided by the firm, but the workers pay their secretary by a special levy for time spent on the councils' business, the firm adding £50 to this levy.

While separate fortnightly councils are held for men and women respectively, interconnection is maintained by the secretaries of one council attending the meetings of the other. Further, joint quarterly meetings of the two councils are held, while special joint councils may be held on three days' notice at the request of either council. Joint committees of men and women are established for catering, thrift, scholarships, travel arrangements, benevolent fund, sick benefit scheme, and so forth.

By courtesy of the council and the board the writer is permitted to quote details of the work of both the men's and women's councils. In the case of both councils the board of directors placed the sum of £2000 at their disposal, to be expended at their discretion. Of this amount the councils expended nearly 75 per cent in their first year. During 1919 the councils recommended the reduction of working hours from 48 to 44 per week, and carried out a ballot concerning the distribution of the work week. Both councils have given considerable attention to education. Jointly, they have arranged for two scholarships at an adjoining training college ("Fircroft") and four scholarships, one man and three women, at Ruskin College, Oxford. Two men and two women have also been sent to take up the industrial training course at Birmingham University, while a musical scholarship has also been awarded. Finally, four scholarships, tenable at Birmingham high schools, have been awarded to the sons of employees, and four musical scholarships at the Midland Institute of Music for two years.

Health and recreation form a considerable part of

the activities of both councils. Efforts have been made to secure the co-operation of employees in attaining greater efficiency by setting up a well-planned suggestion scheme. Piece-rates and wage questions in general receive attention, a piece-rates committee being in existence, of which one-half the membership is composed of representatives of the workers. This committee looks into grievances concerning rates and carries out the conditions of the national agreement covering the industry. This agreement itself, it should be observed, was drawn up by an interim industrial reconstruction council, the type of Whitley Council, adopted in an industry where either employers or workers are not fully organized. Finally, there is a discipline tribunal, also composed of equal numbers of representatives from both sides, before which come all major cases of discipline.

THE REAL VALUE OF THE COUNCIL

On the general question of the value of such councils, the annual reports justify quotation, as the indorsed opinion of all concerned. On the women's side, a live and sound public opinion is said to be in process of creation in the shop committees, from which much useful, constructive criticism has sprung. It is said that the "representatives, both of the management and the workers, are satisfied that there has been a free and full expression of opinion on both sides, and that each side has gained from seeing the other's viewpoint."

On the men's side, the council is said to have displayed a real spirit of co-operation. The earlier tendency to make it a place for the airing of grievances has given place to a desire "to formulate constructive policies with due regard to the interests of the employees of the firm and the public." It is the conviction of those associated with this venture for over two years that "a works council, given a fair chance, will readily develop of itself that right spirit and tradition which are so important to the success of this new *rapproachment* of capital and labor."

In a printed statement, published since this inquiry was begun, the workers' secretary is quoted as claiming that this system of workers' representation has made output a matter of mutual interest, has interested the workers through the development of the suggestion scheme in the improvement of technical methods, has led to improved health in the factory, has made discipline increasingly a matter of mutual concern, has assisted in the absorption of ex-service men, and in general has helped to produce a better corporate spirit. Employers who have investigated the working of the scheme have admitted that it tends, through the activities of the committee system, to foster business sense, increase the experience of the worker, give him greater capacity for teamwork, and widen his outlook beyond his immediate job, thus fitting him to be both a better worker and a more useful citizen.

This interesting concrete case of industrial democracy in practice is by no means unique or isolated. Further evidence of the beneficial effect of such face-to-face discussion and co-operation is readily obtainable elsewhere in Great Britain. For example, Mr. Robert Young, M. P., in a recent speech in London, told of the value of such co-operation as experienced in a large engineering establishment during the war. The management of this shop was having daily trouble over rate fixing. To eliminate this trouble it set up a works committee, with the result that 49 out of 50 potential cases of strikes were settled within the shop without having to be carried to the district or executive committees of the union.

The same speaker quoted an experience of another employer, a number of whose men had gone into the army. This employer determined that the wages of these soldiers should be continued and should be paid to their wives. But he realized that this extra burden could not be carried by the company without the aid of those remaining in the shop. He accordingly set up an organization through which he could reach all his men, then told them of his proposal and made clear to them how it could be carried out only through increased output. He got this increased output, and the men who were fighting their country's fight were paid their wages.

After the testimony of such a firm as that of Messrs. Cadbury Brothers, it is interesting to have in corroboration the testimony of a trade union leader. Mr. Young states several advantages in the following, which bears quotation:

> The value of a works committee lies in the fact that the men will have an opportunity, which in the past they had not, of understanding the difficulties of the employers. It will give the employers an opportunity of bringing grievances before the works committee in relation to the men, because the grievances are not all on one side. It will enable the employers to indicate cases of malingering and bad time-keeping, and various other things which affect industry injuriously, so that the men themselves may be the means of remedying these things. On the other hand, it will enable the men to get beyond their foremen—and, after all, much of the trouble in a workshop is the fault of the foreman. The foreman considers himself "boss." Rightly or wrongly, he had the power of immediate discharge, and as a result many stoppages of work occur. That cannot occur if you have a works committee.

While, however, a works committee will solve many problems, it will not solve all. Much depends on the courage and vision of the employer. On this point the writer cannot forbear quoting H. Mensforth, manager of the Trafford Park Works (Manchester) of the British Westinghouse Company. This gentleman has been extremely successful in dealing with this aspect of industrial management, and expresses himself as thoroughly satisfied with his own works committee. Failures with works committees occur, he believes:

> . . . because the firms instituting them lack either the vision or courage to give the committee scope enough to be really useful, and often, when considering the recommendations coming from them, consider not whether the line of action is just, but whether it is expedient. It requires a good deal of faith in the fundamental honesty of human nature to give a works committee scope enough to be really useful.

This is indeed the final word on the subject of the success or failure of industrial democracy. Faith in the experiment and a big enough chance to justify that faith will in most cases bring success.

Employment management 658.4

Some Things Your Employees Know That You Do Not

By "BILL" HALEY
Foreman

WHEN I say "your employees" I mean your employees who think and observe—only some of them do so—and when I say "know," I mean collectively, not as individuals. In all the employment department cards that I have seen which record the reason why an employee has left his job, I have never seen written some of the reasons which I am going to list below. Why it is that an employee does not like to give his real, definite reason for leaving I do not know, but I am of the opinion that he does not know the real reason himself.

THE "SMASHER" AND THE TROUBLE HE CAUSES

We will take the case of George A—— as an example, not as an isolated case. He gets down to work mornings some time before the gate opens, and to "kill time" pulls out a correspondence school lesson pamphlet and absorbs all the knowledge he can pertaining to his work. "Profiting by the experiences of others," as he calls it.

Employed in this shop is a young fellow whom, for convenience, I have always called a "smasher." I have classified him as a "smasher" because be breaks down prestige.

This "smasher," in looking about for some one to ridicule, which is his chief occupation all day long, happens to single out this correspondence school student. A "striver" we will call him because it is as such I have him classified.

It is not hard for you to imagine the result. Day in and day out for several months this "striver" has to listen to such remarks as a toiler can hurl at his fellow worker who tries to get ahead.

Naturally the "striver" begins to look around for another job, and being a good mechanic and an efficient man he has no trouble in finding a new place. On his employee's record card it generally says, "Gone to better job." He is not going to tell you that he is leaving your plant because his fellow men are making a fool of him, because one good-natured idiot started it.

He is telling the truth when he says he is going to a better job. He means he will be more contented even on less money.

The point I wish to drive home is the fact that in every plant there is one or more good-natured idiots who are always picking out a target for their wit. In doing so they are breaking down the prestige of the undeserving victim, who is perhaps the foreman himself.

Find the "smasher" in your plant or department and transfer him or fire him, and everybody will be happy. It will reduce the labor turnover.

Another cause of turnover that I have never seen listed properly is the well-known "handshaker."

He does not infest the manufacturing end of the game so much as the office, sometimes right under your nose. This is the type who joins the same church, golf club or social club as the man who is his immediate superior, the man who can do the most for him on the job in the line of promotion.

Naturally there are men anxious to get ahead in the same office who will not descend to such means to attain their goal. They see their way blocked to any further advancement and look around for another position. When they leave they say, "Going to a better job." Figure out the cost for yourself.

Here is another cause to make note of. Candidly, in any of the books pertaining to this subject of labor turnover and industrial relations have you ever seen any reference to the silent struggle that takes place in some plants when the employees are voting for their shop-committee representatives?

The union men are anxious to get all their men on the committee, and the non-union men are trying to do the same with their candidates. One side does not expect much sympathy or representation if the other gets elected, and the majority of those who lose the election look for another job in a plant where their kind is in power.

THE EFFECT OF WAGE COMPARISON

Another cause of labor turnover which the employees never definitely explain is wage comparison. I call it a result of the war. Even today there are men holding down jobs which they held during the war and are being paid accordingly. When a mechanic sees what he is receiving in comparison with another man whom he does not consider as his equal insofar as workmanship is considered, he is liable to hunt another job. Thus the gap that lies between the journeyman mechanic and the "war mechanic" is a source of labor turnover.

Sometimes the journeyman leaves the employ of a firm because he thinks he will cause the management inconvenience, and sometimes because he does not know any better. But the fact exists that he leaves, generally, because his pride has been hurt. He believes that the firm that employs him thinks more of a war mechanic than of his trained abilities, as evidenced by the difference in the pay envelopes.

Sometimes his opinion of the war mechanic is unjust. We will say this is so in 50 per cent of the cases; but there are thousands of them, and they are a source of expense and trouble.

Another reason for turnover is the feeling of those I call the "quakers," with no lack of respect for the religious sect of that name. The "quakers," according to my classification, are those who do not care to participate in any labor trouble, sometimes out of respect for the members of their family, who would not be able to weather a period of loafing or idleness, sometimes out of a pure dislike for strife. It is a fact that when a certain class of men scent any kind of labor trouble in a plant they immediately seek a more peaceful plant. Watch for the "quakers" in your plant. They are the men who have to watch their own step financially. They are the barometer of discord in your shop.

Unemployment As An Industrial Problem

By ERNEST S. BRADFORD*

Member of Economic Advisory Committee, President's Conference on Unemployment

IS unemployment at present greater than at previous periods of depression? Is the industrial problem presented more serious now than it has been at other times? And what should be done about it? The number of persons out of work, at the end of September, 1921, was reported by the President's Conference on Unemployment as between 3,500,000 and 5,500,000. Assuming that there are about 4,000,000 less persons on industrial pay-rolls at present than there were at the peak of employment during the early part of 1920, based upon the available indexes of unemployment, how does the present situation compare with previous times of enforced idleness of large numbers of wage-earners?

To answer this question satisfactorily it is necessary to compare definite records covering a number of years in states where a responsible statistical body has collected consistent data, such as the number of persons employed or unemployed at certain regular periods. Two leading industrial states have such records, prepared with considerable care, kept for more than a decade and available in published form to all interested. An examination of these records shows some facts of timely interest.

Massachusetts Statistics

The state of Massachusetts has collected, since 1908, figures concerning the number of organized wage-earners who were out of work at the end of each quarter. These reports cover three-fourths of all the workers who are members of labor organizations in that state, some 250,000 in number, and while not absolutely precise in every respect, are believed nevertheless by statisticians to be reasonably exact, and to reflect with substantial correctness the changes in unemployment between one date and another. The chart of Fig. 1, based on these figures, shows graphically the relative percentage of unemployed among organized workers in Massachusetts in December 1920, and at the present time, compared with 1908 and 1914:

From this chart it is evident that such unemployment as it represents, which is believed to be fairly typical of all industrial unemployment in that state, was much greater at the close of 1920 than at the highest point of 1908 or 1914, and that even at the end of the third quarter of 1921, was greater than either seven or fourteen years ago. This was to be expected after such a violent dislocation of the industry of the world as must necessarily accompany a world war of unheard-of proportions. In Massachusetts, unemployment is evidently worse than in previous depressions. How is it in other states?

New York and Wisconsin Data

In New York and Wisconsin there are available a different set of figures bearing on this question; but they are significant ones, namely, the average number of factory employees on pay-rolls during each month from 1914-1915 to the present. The curves of factory employment in these two states are shown by the chart of Fig. 2. On this chart, the depression of 1914-1915 is indicated by a drop below the 100 per cent level, rising again after the middle of 1915 to the heights of the busy war years of 1916, 1917, and 1918, dropping after the signing of the armistice, in November 1918, but rising to a peak again early in 1920. From that point to the present there has been a sharp decline. The line of normal increase in the number of factory workers indicates the point at which the curve should now be. It is further below this line of normal employment than in 1914-1915. These states, therefore, show the same general condition as does Massachusetts, except that the figures do not go back so far. There is reason to believe that we are suffering from the greatest amount of unemployment experienced at any time in the past 20 years.

There are certain hopeful features of the present situation. One is the decline in unemployment in Massachusetts since January 1921. In this state, which was one to be hit earliest, improvement has already begun, a cheering fact not to be lost sight of. It is likely that other states will follow somewhat the same order of recovery as that in which they were affected by the depression. At the same time its importance should not be exaggerated. In New York, the bottom has been reached, apparently; we may hope for a rise, since during the past two months the change in the number of workers employed in factories has been less than 1 per cent. We certainly need this assurance, for during the winter just ahead of us there will be, beside the normal unemployment of every year due to sickness and the usual labor turnover, a large seasonal unemployment, particularly in the building trades, and also the depressional unemployment which has already interfered so powerfully with business. We shall have to put forth every effort to reduce the existing enforced idleness of our wage-earners, if they are to escape widespread hardship, misery, and reduced self-respect, during the next few months.

The seasonal element in unemployment is no small factor in many industries. In the building trades and among the clothing workers there is a marked seasonal variation, the winter bringing a peak of unemployment

* Mr. Bradford has had an unusually extensive connection with American industry. Following his university course, where he specialized in commerce and economics, he spent two years in becoming familiar with industrial plants, visiting in all something over five hundred in forty states. He then took post-graduate work in industry and business at the University of Pennsylvania, making particular studies of potteries, glass factories, and foundries; then followed five years in statistical research for the Department of Commerce. In 1916 he undertook a study of the market for rubber goods for the largest manufacturer in that line, and in 1918 was commandeered by the government as a statistician and analyst for the Emergency Fleet Corporation. Still later he was director of the Business Research Bureau of the McGraw-Hill Book Company and Manager of the Research Department of the Erickson Company.

in the former industry, while in garment-making there are two slack seasons each year, coming after the rush of trade in the fall and the spring. The charts, Figs. 3 and 4, show the situation in New York State over a period of years.

The mild winters of 1905-1906 and 1912-1913 are reflected in the reduced unemployment indicated by the

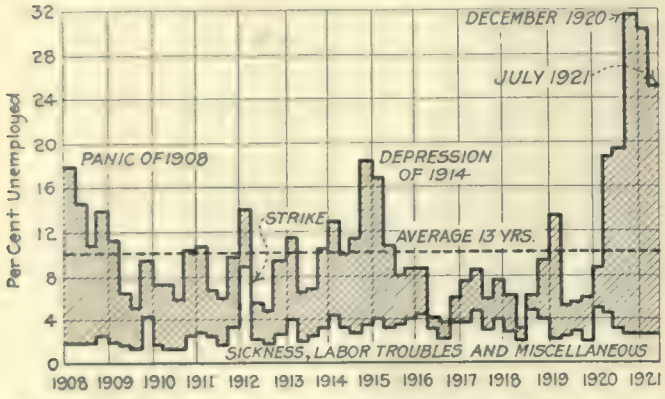


FIG. 1 CHART SHOWING FLUCTUATIONS IN UNEMPLOYMENT IN MASSACHUSETTS FROM 1908 TO 1921

This chart shows the percentage of organized wage-earners unemployed at the end of each quarter. About 250,000 wage-earners in 1920 were covered by these reports, of whom about 80,000 were unemployed January 1, 1921. The highest point of unemployment in Massachusetts was reached at the close of 1920. It has fallen since.

chart. Other industries show less seasonal unemployment and more due to the effect of business prosperity and depressions. The chart of Fig. 5 shows unemployment among organized workers in the metal trades in the state of New York and indicates the wave-like movement of the successive business cycles, peaks showing in the years 1908, 1911, and 1914-1915.

NATURE OF THE INDUSTRIAL PROBLEM

From whatever cause, unemployment, when it reaches large proportions, constitutes a grave industrial problem, which concerns manufacturer and merchant, as well as the public.

The reduction of the buying power represented by 4,000,000 wage-earner-consumers out of work and without income—is no slight subtraction from the total daily demand on American dealers and producers. At an average rate of pay, which is purposely placed low in order not to overestimate its volume, it represents a loss of between 12 and 20 million dollars a day, say $15,000,000. The average wage of the common labor employed by the United States Steel Corporation was about $4 per day in June, 1921; more skilled labor is more highly paid. For the 275 to 300 working days of the past year, the time lost in wages runs up to between $3,500,000,000 and $4,500,000,000. If to this is added the wages lost through part-time employment, the total can be scarcely less than $5,000,000,000.[1]

Five billion dollars less in the tills of merchants means a correspondingly lower volume of orders for factories; when the consumer stops calling for goods the factory wheels cease turning. It is the consumer that we are all producing for. When factories close more men are out of work and without purchasing power from current earnings, and so it goes, in a vicious circle. The more unemployment, the less the demand for goods; the less the demand, the more factory shutdowns; the more the shutdowns, the more unemployed and the less the demand for goods. This is the immediate and temporary reduction of buying power due to unemployment.

There is also a *permanent* reduction of buying power, if we view unemployment from another business angle. The lowering of the demand level and the standard of living of thousands of workers, which accompanies a severe depression such as the present one, means less future business for all. The workman who has become a consumer of good shoes and collars, a buyer and reader of newspapers and magazines, a user of many non-luxury conveniences not previously afforded, ceases on account of lack of income to be able to include these among the products which he commonly buys and uses. His standard of living drops back, perhaps for a time to lower levels than ever before, and recovery is very slow. It is to the interest of the entire community to maintain a reasonably high level of general well-being. To this end its workmen must be kept employed and earning fair wages. This is only good business.

The further question which is always present at such a time is whether it is good policy to let our human machinery deteriorate. Unemployment means a lowering of physical vitality through less adequate subsistence, the reduction of the initiative due to surplus energy, and the lessening of the self-respect that comes from having a savings account. A bare worrying-along is helped out by the aid of friends and, as a last resort,

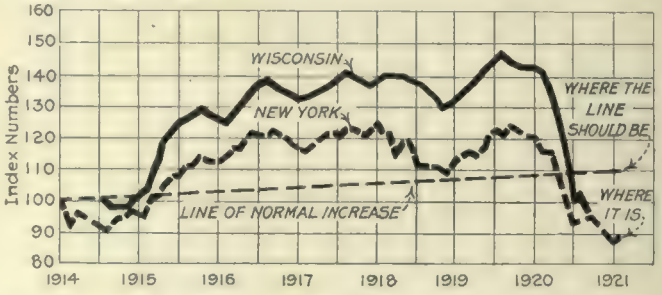


FIG. 2 CURVES SHOWING HOW UNEMPLOYMENT HAS VARIED IN THE STATES OF NEW YORK AND WISCONSIN FROM 1914 TO 1920

assistance from relief organizations. In this respect what is needed is "a job, not charity." All these considerations constitute part of the human side of the business problem involved.

TWO CLASSES OF MEASURES FOR RELIEF

Of the two classes of measures which may be offered to meet the situation, one is of an immediate and temporary character, the other more permanent and fundamental. The purpose of the former is to reduce the suffering from cold and hunger likely to arrive with the coming winter; the other looks to the effectual reduc-

[1] Other estimates place this at $6,000,000,000.

tion of the unemployment which afflicts us year after year, and which represents a continuous drag on the prosperity of American wage-earners, producers, and distributors alike.

The most direct line of attack centers about the continuing of existing work and the making of more work, the spreading out of what work there is and, finally, the relief of those in distress. This means keeping the factories going so far as possible, manufacturing to stock when the immediate demand is low, and storing goods, so far as is practicable, in the case of some stable commodities. Doing repair work now, rather than later, will keep some of the regular force occupied. The spreading out of the available work over a larger number of persons, through part-time work, rotation of shifts and shortened work-days, gives each worker a share, that is, a small one rather than employing part of the force full time and laying off the rest. So much for the manufacturer's part of the job, for he is the employer in whose hands lies most of the responsibility for keeping his force working. Some help in the same direction may be had through the making of work by the government, such as road building, housing projects, and the like. Last of all, is relief, to be administered by providing emergency jobs, rather than emergency soup kitchens, wherever possible.

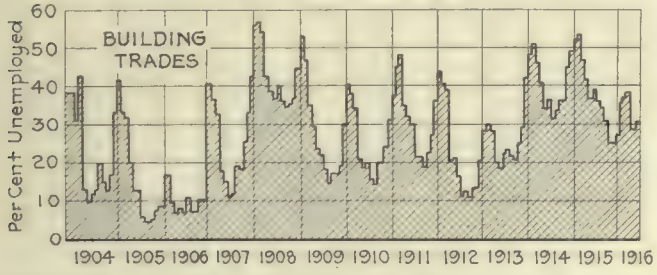


FIG. 3 CHART SHOWING PERCENTAGE OF UNEMPLOYMENT AMONG ORGANIZED WORKERS IN THE BUILDING TRADES OF NEW YORK STATE

The second group of remedies, more fundamental in character, aims at improving business conditions and lessening unemployment by this means. The reduction of costs, through lower raw materials, economies of operation, lower overhead costs and wages, is relied upon to make lower prices of goods possible and start buying by the public. Resumption of foreign trade, the stabilizing of the tariff, and tax legislation, are also recommended. Other basic factors included are reduced armaments, with their burden on the people, the stabilizing of foreign exchange, and improved railway conditions. These all proceed on the theory that we should center our efforts on reviving business and creating a renewed market for goods, thus automatically starting the wheels of industry and removing unemployment.

The same group of measures attempts to reduce seasonal unemployment through distributing production more evenly over all the months of the year, and also to avoid some of the evils of business depressions through planning ahead and forecasting the market, estimating the probable future ups-and-downs of business through a study of business cycles.

So complex a set of causes demands a number of remedies, each of which is intended to play its part in improving the situation. There is no single panacea for unemployment.

This was recognized by the President's Conference on Unemployment, and its recommendations attacked the problem from several sides at once. They proceed

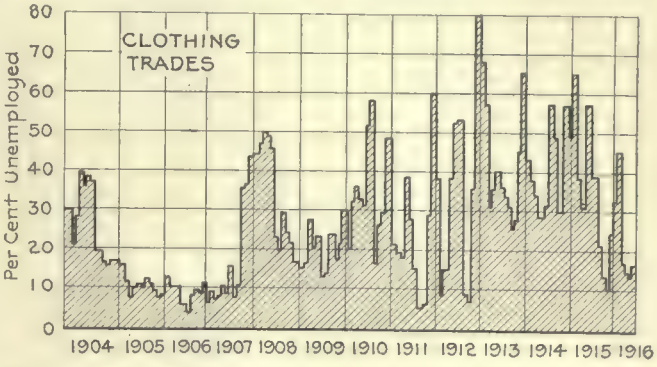


FIG. 4 CHART SHOWING PERCENTAGE OF UNEMPLOYMENT AMONG ORGANIZED WORKERS IN THE CLOTHING TRADES OF NEW YORK STATE

on the belief that the employer is the principal element in the situation and the one who is in a position to take conditions most effectively in hand; at the same time, the government should help, through public works, and local authorities are to supervise matters in each locality. The mayor is the natural head of these activities in each city. "The proportionate adjustment of the inequalities of deflation," that is, bringing about a more even decline in the prices of commodities, is also regarded as a factor of importance in expediting the return to normal business.

Not being a legislative body, the conference was limited to presenting recommendations. It was a staff body, adviser-at-large to the employers' cities, and legislative bodies of the country; they are the ones to carry out the measures recommended.

NEED OF ADEQUATE EMPLOYMENT STATISTICS

One of the first and most obvious needs of industry is the keeping of adequate unemployment statistics, collected regularly by a competent body in each industrial state. Until this is done it will be exceedingly difficult, as it is now, to diagnose business ills correctly. An unemployment curve is an excellent index of general business conditions.

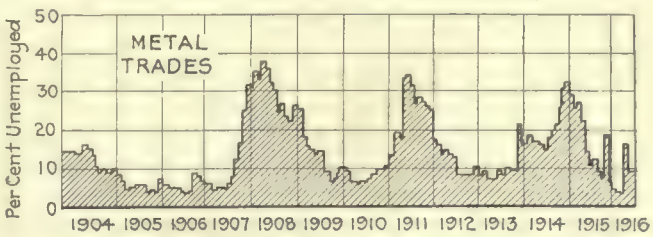


FIG. 5 CHART SHOWING PERCENTAGE OF UNEMPLOYMENT AMONG ORGANIZED WORKERS IN THE METAL TRADES OF NEW YORK STATE

There must be a permanent system of employment exchanges or clearing houses for employer and worker

alike, neutral and unbiased—an efficient means of bringing together the work to be done and the men to do it. Whether these should be a series of state bureaus or a system of affiliated local state and federal officers, is a matter to be studied more fully and carefully worked out. For common and semiskilled labor, public agencies have proved to work better than private employment bureaus. In the special professions, private agencies will continue to do the work better. Unemployment and the need of co-ordinating worker and job is greatest in the lower paid ranks of labor.

Unemployment through sickness, accidents, and strikes, amounting to about ¼ of the total normal unemployment, should also be reduced, through better public health control, company medical work, and efforts to develop good-will between men and management. This is a separate subject but pertinent, nevertheless, in making our labor force more effective.

How the Problem May Be Solved

The putting forth of every effort will undoubtedly reduce considerably the number of those who would otherwise be out of work; it will not remove unemployment entirely. Keep the wheels turning, work the factory force part time when full time is impossible, provide clearing houses to bring men and work together, supervise situations locally through mayors—these are the obvious things to do at once. And, in order to better the conditions next time—for there will be a next time of unemployment, perhaps some seven years hence, and still others at periodic intervals—we should start at once collecting statistics, regularizing seasonal industries, and studying business cycles. Since seasons of unemployment are bound to come let us get ready for them. Eventually, why not now?

Absenteeism *658.427*

What Is Absenteeism?

By J. M. HADLEY

Industrial Engineer, J. P. Gordon Company

JUST what is "absenteeism" in industry and how shall figures of absenteeism be compiled? This is a question which puzzles many, for there is almost the same lack of uniformity in figuring percentages of absenteeism as there was, and to a certain degree still is, in figuring percentages of labor turnover. This is particularly unfortunate in view of the fact that figures on absenteeism are used chiefly for comparative purposes. That is to say, the full benefits of intelligent and valuable comparison are not being gained because of the lack of a standardized method of figuring. This is true in spite of the fact that percentages of absenteeism are less influenced by living, working, and trade conditions than are percentages of labor turnover.

To begin with, we must differentiate between absence and tardiness; at what point does tardiness stop and absence begin? Opinion seems to be about equally divided between two definitions of tardiness. One definition—the loss of time of less than the full work period—requires no explanation, although it would seem that the loss of so long a possible period of time could not logically be considered as tardiness. The other definition—the loss of time of less than either one of the two parts into which the working period is generally divided—is a more logical, although complicated, conception.

Under the second definition, if the shift is from 8 A.M. to 12 A.M., and from 1 P.M. to 5 P.M., an employee would be considered tardy who:

1. Reported for work after 8 A.M. but before 12 P.M. and worked the remainder of the shift.
2. Reported for work after 1 P.M. but before 5 P.M. and worked the remainder of the shift, having previously worked the entire first period of the shift.
3. Reported for work after 1 P.M. but before 5 P.M. and worked the remainder of the shift, but who had not worked during any part of the first period of the shift. (In this case the loss of the first period of the shift would be considered as absence.)

Any loss of time, therefore, occurring at the *beginning* of either period of the shift, but not the loss of the entire period of the shift, would be considered as tardiness. All other loss of time, not occasioned by the employer due to lay-offs, breakdowns, and similar causes, would be considered as absence. It is necessary to specify tardiness as occurring at the beginning of the shift, since the loss of a part of the work period due to an employee's leaving before the regular quitting time could not by any means be considered as tardiness and therefore must be considered as absence.

How Long Should Absent Men Be Carried?

In considering absenteeism, two other arbitrary decisions must be made, one as to how long an employee, absent without excuse and for reasons known or unknown, will be carried on the pay-roll before he is dropped; and another, how long an employee, absent with the knowledge and consent of his employer, will be carried on the pay-roll and figured in the records as an absentee.

It is common practice to release automatically, after a predetermined period, any employee who absents himself without satisfactory reason. The number of days which elapse before such a release is put through, vary, although the majority of industries permit an absence of three consecutive working days and consider the Saturday half-day as a full day in computing this period. Also, if the first absence is less than a full day but more than a half, it is considered as a full day; if less than a half day, it is not counted.

Three days would seem long enough for any employee who wished to retain his job to notify his employer of his reason for absence by mail, by telephone, or by messenger. A longer time should be unnecessary and a shorter period might be considered as unfair to the employee.

In the case of absences excused in advance or considered justified by the sudden rise of conditions which make impossible an advance request for leave of absence, there is, however, room for considerable difference of opinion. For example, if an old and valued employee whose service it is desirable to retain is the victim of an accident or illness which keeps him away from his work for a period of weeks, should such long continued absence be figured in the absentee percentages whether or not his place is filled temporarily or otherwise?

The question of replacement would seem to be the factor which would best decide this point. If the industry can afford to hold open a place for the absent worker, his period of absence should logically be figured in the absentee percentages. If he is replaced, even though temporarily, by the hiring of a new employee to fill his place or to fill the vacancy caused by the transfer of another employee to his place, he should be released from the pay-roll and not considered as an absentee. While this method would break the continuity of service as used in allowing for pensions, pension systems can be arranged to provide for absence.

How Shall Absenteeism Be Figured?

Having now arrived at a definition of tardiness and absence and the length of time and conditions under which an employee will be carried and considered as an absentee, we must next decide upon the method of computing percentages of absenteeism. Before we can do this, however, we must decide whether we are chiefly concerned in the number of employees who are absent or in the amount of time lost. While it is true that the fewer the number of employees who cause a given amount of absence, the better it is for the industry, the number of absentees in itself is no index to the amount of absenteeism. An industry is affected not so much by the number of employees who are tardy or absent as by the amount of time lost through such tardiness and absence resulting in a corresponding loss of production.

The amount of time lost might be figured either in days or in hours. If figured in days, however, the result would not be an accurate gauge of the amount of time lost, even though nothing less than the loss of a full day were considered as absence, for no account of the time lost through tardiness would be included. nor would an account of the possible difference in lengths of shifts or the possibility of "short" days. Neither would it afford a fair basis of comparison between industries, because of the difference in the number of working hours.

If, however, we consider time lost in terms of hours. we can figure the number of hours lost both by tardiness and by absence as against the total possible number of hours which the employees were privileged to work; by so doing we can ignore the differentiation between tardiness and absence and thus have a figure which will be at all times comparable. The total possible number of hours which employees were privileged to work should be regarded as the full work period of the industry less the time lost through holidays and enforced lay-offs and the time lost through the release from the pay-roll of employees after the commencement of the period and the time lost in the period by the engagement of new employees after the start of the period.

For example: An industry employs 100 men and works a 50 hr. week, 9 hr. per day for 5 days and 5 hr. on Saturday. On Wednesday due to a breakdown in the power plant, the plant closed down 2 hr. ahead of the regular time; also 2 men are released during the week—one on Tuesday at the end of the day and one on Thursday at noon. In addition one new man is hired and starts to work at the regular time on Thursday morning. Therefore—

98 men could have worked 48 hr. each, or	4,704 hr.
1 man could have worked 2 days of 9 hr. each, or	18 "
1 man could have worked 2 days of 9 hr. each, 1 day of 7 hr., and 1 period of 5 hr., or	30 "
1 man could have worked 2 days of 9 hr. each, and 1 day of 5 hr., or	23 "
Making a total possible number of	4,775 hr.

In figuring the total possible hours, overtime would best be disregarded. It is not a part of the regular work period, is generally spasmodic, rarely affects the entire force and is of no particular value to the absentee percentages.

The figures for the total possible number of hours are not difficult to compile with the help of the time-keeping department, even in the largest plants.

A Suggested Standard Method

The method suggested for figuring absentee percentages is, then, this:

1. That no differentiation be made between absence and tardiness, but that absenteeism be considered as the amount of time lost in units of hours.
2. That unexcused absentees be dropped from the pay-roll after 3 consecutive days of absence, that the Saturday half-day be considered as a full day, and that the first period of absence, if less than a full day but more than either of the two work periods, be considered as a full day, and if less than either of the two work periods be disregarded.
3. That excused absentees be carried and figured in the percentages if they are not replaced directly or indirectly by the engagement of a new employee.
4. That overtime be disregarded.
5. That the formula be:

$$\frac{\text{Total hours of lost time}}{\text{Total possible working hours}} = \text{Percentage of absenteeism.}$$

The Unemployment Conference

Recommendations for Emergency Measures, and Permanent Remedies

THE Conference on Unemployment,[1] appointed by the President to study and outline a solution for a great national problem, met in Washington on September 26, and adjourned on October 13. With very few preliminary moves it began its work with the selection of nine subcommittees to formulate a complete program. Under the direction of Secretary Hoover, who was designated chairman, the work has proceeded with little debate, and without acrimonious controversy; and the body drew upon itself the name of the "Conference of Reassurance."

At the outset a dividing line was drawn between emergency measures and those of a permanent nature. Through it all the thesis has been held, "The only remedy for unemployment is employment."

The Subcommittees

The nine subcommittees were named to consider the following matters: unemployment statistics; employment agencies and registration; emergency state and municipal measures and public works; emergency measures by manufacturers; emergency measures in transportation; emergency measures in construction; emergency measures in mining; emergency measures in shipping, and public hearings.

The committee on unemployment statistics reported that there were not fewer than 3,700,000 nor more than 4,000,000 fewer persons on industrial pay-rolls in the United States at present than in January 1920. If the 3,700,000 estimate of the committee is correct it is believed there are something like 2,500,000 unemployed who may be classed as emergency cases. The committee reported that conditions had improved steadily in the last two months.

The article on page 299 of this issue by E. S. Bradford, who is a member of the Economic Advisory Committee,[2] indicates the unemployment situation today compared with the critical years of 1914 and 1908, and reflects to a degree the nature of the statistical material which was presented to the conference.

The first attack was made on an emergency program. On September 29, the conference as a whole adopted recommendations as follows:

1. The conference finds that there are, variously estimated, from 3½ to 5½ millions unemployed, and there is a much greater number dependent upon them. There has been an improvement, but pending general trade revival this crisis in unemployment can not be met without definite and positive organization of the country.

2. The problem of meeting the emergency of unemployment is primarily a community problem. The responsibility for leadership is with the mayor and should be immediately assumed by him.

3. The basis of organization should be an emergency committee representing the various elements in the community. This committee should develop and carry through a community plan for meeting the emergency, using existing agencies and local groups so far as practicable. One immediate step should be to co-ordinate and establish efficient public employment agencies and to register all those desiring work. It should co-ordinate the work of the various charitable institutions. Registration for relief should be entirely separate from that for employment.

4. The personnel of the employment agencies should be selected with consideration to fitness only and should be directed to find the right job for the right man and should actively canvass and organize the community for opportunities for employment. The registry for employment should be surrounded with safeguards and should give priority in employment to residents. Employers should give preference to the emergency employment agencies.

5. The emergency committee should regularly publish the numbers dependent upon them for employment and relief that the community may be apprised of its responsibility. Begging and unco-ordinated solicitation of funds should be prevented.

6. Private houses, hotels, offices, etc., can contribute to the situation by doing their repairs, cleaning, and alterations during the winter instead of waiting until spring, when employment will be more plentiful.

7. Public construction is better than relief. The municipalities should expand their school, street, sewage, repair work, and public buildings to the fullest possible volume compatible with the existing circumstances. That existing circumstances are favorable is indicated by the fact that over $700,000,000 of municipal bonds, the largest amount in history, have been sold in 1921. Of these, $106,000,000 were sold by 333 municipalities in August. Municipalities should give short time employment the same as other employers.

8. The governor should unite all state agencies for support of the mayors and, as the superior officer, should insist upon the responsibility of city officials; should do everything compatible with circumstances in expedition of construction of roads, state buildings, etc.

9. The federal authorities, including the federal reserve banks, should expedite the construction of public buildings and public works covered by existing appropriations.

10. A congressional appropriation for roads, together with state appropriations amounting to many tens of millions of dollars already made in expectation of and dependence on federal aid, would make available a large amount of employment. The conference under existing circumstances, notwithstanding various opinions as to the character of the legislation and the necessity for economy, recommends congressional action at the present session in order that work may go forward.

11. The greatest area for immediate relief of unemployment is in the construction industry, which has been artificially restricted during and since the war. We are short more than a million homes; all kinds of building and construction are far behind national necessity. The Senate Committee on Reconstruction and Production, in March of this year, estimated the total construction shortage in the country at between 10 and 20 bil-

[1] Delegates to the Conference: Secretary of Commerce Hoover, *Chairman*; Secretary of Labor Davis, Winslow B. Ayer, Julius H. Barnes, William B. Butler, W. S. Carter, Elizabeth Christman, Edgar E. Clark, John T. Connery, Mayor James Cousens, Joseph H. De Frees, T. E. Edgerton, W. K. Field, Mortimer Fleishacker, Samuel Gompers, Jackson Johnson, John H. Kirby, William Kelly, W. M. Leiserson, John L. Lewis, Bascom Little, C. H. Markham, General Richard C. Marshall, Jr., Charles P. Neill, Thomas V. O'Connor, Raymond A. Pearson, Mayor Andrew J. Peters, E. M. Poston, W. C. Proctor, Harry S. Robinson, Charles M. Schwab, Ida M. Tarbell, Ernest T. Trigg, Mary Van Kleeck, Matthew Woll, Evans Woolen, Clarence Mott Wooley, Colonel Arthur Woods.

[2] Economic Advisory Committee: William S. Rossiter, *Chairman*; John B. Andrews, George E. Barnett, E. S. Bradford, Bailey B. Burrage, Henry S. Dennison, Davis R. Dewer, Carroll W. Doten, Edwin F. Gay, Clyde L. King, Samuel A. Lewisohn, Otto T. Mallery, Samuel McCune Lindsay, Wesley C. Mitchell, Henry R. Seager, Edward R. A. Seligman, Sanford E. Thompson, Walter F. Willcox, Leo Wolman, Allyn A. Young.

lion dollars. Considering all branches of the construction industries more than two million people could be employed if construction were resumed. Undue cost and malignant combinations have made proper expansion impossible and contributed largely to this unemployment situation. In some places these matters have been cleaned up. In other places they have not and are an affront to public decency. In some places these things have not existed. In others costs have been adjusted. Some materials have been reduced in prices as much as can be expected. Where conditions have been righted, construction should proceed, but there is still a need of community action in provision of capital on terms that will encourage home building. Where the costs are still above the other economic levels of the community there should be searching inquiry and action in the situation. We recommend that the governors summon representative committees, with the co-operation of the mayors or otherwise as they may determine, to (*a*) determine facts; (*b*) to organize community action in securing adjustments in cost, including removal of freight discriminations, and clean-out campaigns against combinations, restrictions of effort, and unsound practices where they exist, to the end that building may be fully resumed.

12. Manufacturers can contribute to relieve the present acute unemployment situation by:

(*a*) Part time work, through reduced time or rotation of jobs.

(*b*) So far as possible, manufacturing for stock.

(*c*) Taking advantage of the present opportunity to do as much plant construction, repairs, and cleaning up as is possible, with the consequent transfer of many employees to other than their regular work.

(*d*) Reduction of the number of hours of labor per day.

(*e*) The reduction of the work week to a lower number of days during the present period of industrial depression.

(*f*) That employees and employers co-operate in putting these recommendations into effect. A large number of employers have already, in whole or in part, inaugurated the recommendations herein set forth, and for this they are to be commended, and it is earnestly urged upon those employers who have not done so to put same into use, wherever practicable, at the earliest possible opportunity.

(*g*) Specific methods for solution of our economic problems will be effective only in so far as they are applied in a spirit of patriotic patience on the part of all our people.

During the period of drastic economic readjustment through which we are now passing, the continued efforts of anyone to profit beyond the requirements of safe business practice or economic consistency should be condemned. One of the important obstacles to a resumption of normal business activity will be removed as prices reach replacement values in terms of efficient producing and distributing cost plus reasonable profit.

We, therefore, strongly urge all manufacturers and wholesalers who may not yet have adopted this policy to do so, but it is essential to the success of these measures when put into effect that retail prices shall promptly and fairly reflect the price adjustment of the producer, manufacturer, and the wholesaler.

When these principles have been recognized and the recommendations complied with, we are confident that the public will increase their purchases, thereby increasing the operations of the mills, factories, and transportation companies, and consequently reducing the number of unemployed.

EMERGENCY MUNICIPAL MEASURES

On October 5, two more recommendations were adopted; the first on emergency state and municipal measures and public works. These recommendations follow:

Cities and towns must be relied upon for immediate attack upon the emergency created by unemployment. Whatever is done must take place in local communities and the citizens of such communities are the ones responsible and capable of seeing that the necessary measures are carried out. They but repeat the first principle of American public life, reliance upon local initiative and obligation.

The mayors of cities are the natural and authorized leaders and directors of their communities for all emergencies affecting the public welfare. In the present crisis the mayor should head the effort of each locality and organize the most influential and representative citizens and agencies to handle the local situation.

In the interest of speed, order, and effectiveness the chief official of each community should immediately marshal all its resources. The mayor and his organization should furnish such leadership as will enlist the support and utilize the services of all.

The governor of each state as the superior officer of all local officials is urged to call emphatically to the attention of communities and mayors their peculiar responsibility and fitness for handling this unemployment situation.

The methods of accomplishing results must vary with each locality and no methods capable of universal adoption can with safety be recommended. Therefore, specific recommendations to communities are confined to the very urgent one that, following the leadership of their mayors with united local committees, they accept this primary obligation to the full. However, the following suggestions or general principles based on past experience are respectfully offered to such communities:

1. The mayor's committee should try to harmonize the operations of all the different agencies which are trying to relieve the situation, so as to avoid clashing and wasted effort.

2. The facts of the extent and distribution of unemployment should be in the possession of the committee, and should be made available to the public.

3. Each locality should have a public employment bureau.

4. The mayor's committee should try to get the whole community behind the effort to speed up the construction of public improvements. In a period like this there should be the greatest activity in putting up new schools and other needed public buildings, and in necessary repairs and improvements in streets, bridges, sewerage, public utilities, parks, and other municipal works.

5. Every effort should be made to provide real work by stimulating industry. Meanwhile, each industry should be urged so far as possible to keep together its own force by giving at least part time employment.

6. In some cities "Spruce-Up" campaigns have proved good. In these every one is urged to do at once whatever is needed in the line of sprucing up his property. This applies both to public and private owners of property, to small householders and flat renters as well as to large companies, hotels, theaters, etc. It should be made clear to all that money spent in this way, stimulating the regular activities of industry, will help to reduce unemployment far more than any other aid.

7. It is important to strengthen and increase the resources of the local family welfare agencies which are best prepared for effective service, and to give them vigorous support in order that they may deal promptly and adequately with the needs of families and individuals. The burden of meeting these needs should be borne not by a selected few but by many. Provision should be made for maintaining the usual facilities for the homeless, and for the relief of poverty arising from sickness, from widowhood, from mental or physical handicaps, in order that these may not be a complicating factor in the problem of unemployment. Cities that have municipal lodging houses or other adequate provision for the homeless man find that this makes possible differentiating the two problems of the resident and floating unemployed, and enforcing regulations against vagrancy and begging.

8. Consideration should be given to the practicability of keeping children in school as long as possible in order that they may not compete for the insufficient number of jobs and also that they may profit by additional schooling and the postponement of the beginning of wage-earning. It may be found desirable to give scholarships to minors beyond the compulsory school age, and the public schools have provided special vocational training for them so that the period of unemployment may be used to equip them for better positions.

9. It must always be remembered that an unemployed person needs work, first and last, and that the community should relax no effort to find work for him, regarding other aid only as a

temporary measure to be superseded at the earliest possible moment by work. The community should be able to handle the situation in such a way as to make bread lines unnecessary. Each community should remember that hunger and want must be relieved, and it should always be prepared to take whatever measures may be needed to prevent human suffering.

10. We suggest that each city avail itself of the experience of others. The methods of Detroit, Boston, Philadelphia, Milwaukee, and New York have been brought to the attention of the conference, and we are certain that the mayors of these and other cities will be glad to answer inquiries.

EMPLOYMENT AGENCIES

A group of eleven recommendations was also presented by the committee on employment agencies and registration:

1. However grave the crisis of unemployment, a well organized community can develop untouched opportunities for employment.

2. In this crisis of unemployment, the responsibility in each community for leadership should be directly assumed by the mayor. However, where an effective agency in a community is now successfully functioning, the mayor should support its work.

3. The need for emergency measures having been ascertained, the co-operation of all elements in the community should be enlisted through the formation of an "emergency committee."

4. This "emergency committee" should provide a centralized registration of the unemployed, and, by co-operation with, and not displacement of, proper and established agencies, facilitate the placement of the unemployed.

5. This registration for employment should be wholly separate from any registration for relief of distress.

6. Competent and impartial executive direction and staff personnel is essential, in order that applicants may be properly selected on the basis of fitness for specific work, and thus the confidence of employers and workers be secured.

7. In selecting personnel for the serious business of this emergency work, no consideration should be allowed other than fitness for its performance.

8. Energy and skill in management of the service will certainly facilitate the connection of men with work, and will more directly locate and develop opportunities for employment, otherwise not ascertained.

9. For quick and efficient service, local community effort is the most effective, but the local agency should co-operate with state and federal employment organizations and obtain all possible aid from these sources.

10. Emergency employment service should be stimulated by some method of report of progress and accomplishment, by which its value can be measured.

11. The experience of communities already operating will be helpful to all, and this committee is therefore preparing a pamphlet of suggested practical steps for general guidance. The main reliance, however, must be in the resourcefulness and self-reliance of the people of each community, familiar with its own local conditions.

To co-ordinate the work of local agencies, Secretary Hoover designated Col. Arthur Woods as head of a special committee which is to receive reports from various other committees and is to stimulate communities to do their utmost. It is expected that this special committee will act as a clearing house for methods which may be used in various localities.

The report of the subcommittee on construction industries was unanimous and was adopted by the conference as a whole. It opened by quoting an estimate made in March of this year by the Senate Committee on Reconstruction and Production: "The total construction shortage in the country at present is between $10,000,000,000 and $20,000,000,000," and then went on to declare that a return of confidence in values in construction will assure more employment than in any other field. The three outstanding factors which have the greatest bearing on the resumption of construction activities are financing, material costs, and labor costs.

MEASURES FOR PERMANENT "RECOVERY OF EMPLOYMENT"

On October 11, the conference as a whole adopted general recommendations embodying measures for the permanent "recovery of employment." The eight points follow:

1. Readjustment of railway rates to a fairer basis of the relative value of commodities, with special consideration of the rates upon primary commodities, at the same time safeguarding the financial stability of the railways.

2. Speedy completion of the tax bill with its contemplated reduction of taxes, in order that business now held back pending definite determination may proceed.

3. Definite settlement of tariff legislation in order that business may determine its future conduct and policies.

4. Settlement of the financial relationships between the government and the railways, having in mind the immediate necessity for increased maintenance and betterments, making effective increased railway employment and stimulation of general employment, in order that the railways may be prepared for enlarged business as it comes.

5. Limitation of world armament and consequent increase of tranquility and further decrease of the tax burden not only of the United States but of other countries.

6. Steps looking to the minimizing of fluctuations in exchange, because recovery from the great slump in exports (due to the economic situation in Europe) cannot make substantial progress so long as extravagant daily fluctuations continue in foreign exchange, for no merchant can determine the delivery cost of any international shipment.

7. Definite programs of action that will lead to elimination of waste and more regular employment in seasonal and intermittent industries, notably in the coal industry, in order that the drain upon capital may be lessened and the annual income of workers may be increased.

8. In the field of all the different industries and occupations the rapidity of recovery will depend greatly upon the speed of proportionate adjustment of the inequalities in deflation. A table is attached hereto, drawn from various sources, showing the percentage of present levels above the levels of the same commodities and services of the pre-war period. It will be observed that agriculture has reached an unduly low plane, while transportation, coal, and some branches of the construction industries are of the highest. It will also be observed that this is an entire disproportion between the price of the primary commodities and the ultimate retail price. These disproportionate increases in the progressive stages of distribution are due to increased costs of transportation, enlarged profits, interest, taxes, labor, and other charges.

If the buying power of the different elements of the community is to be restored, then these levels must reach nearer a relative plane. For example, the farmer cannot resume his full consuming power and thus give increased employment to the other industries until either his prices increase or until more of the other products and services come into fair balance with his commodities, and therefore the reach of his income.

On October 13, the conference adjourned to reconvene on the call of a special standing committee. During the last hours preceding adjournment a group of majority and minority reports were brought in from several committees, which were permitted to be presented as expressing the sentiments of several groups, although these were not adopted by the conference as a whole.

THE LABOR SUMMARY

Statistics and News from Industry

Employment, Industrial 331.1

Employment Continues to Increase

THE upward trend in industrial employment which began in August continued during the month of September, according to test figures gathered by the U. S. Employment Service of the Department of Labor. The data upon which this estimate is based were compiled from returns made by 1428 concerns who normally employ 500 or more workers, and the details of the figures thus secured are given in a somewhat condensed form in Table 1. A total of the figures from all industries reporting shows that while in August there were 1,526,479 workers on the pay-rolls, this number increased in September to 1,544,529, a gain of 18,050, or approximately 1.2 per cent. Figures showing the change since the first of the year show, however, a loss in employment totaling 83,605 workers, or slightly over 5 per cent.

TABLE I. THE TREND OF EMPLOYMENT IN 1428 AMERICAN INDUSTRIES DURING SEPTEMBER, 1921

(Compiled by the U. S. Employment Service, U. S. Dept. of Labor)

Industrial Group	Number on Pay-Roll		Net Change August to September	Net Change Since Jan., 1921
	August 31	Sept. 30		
1. Food and Kindred Products	133,321	138,086	+4,765	+642
2. Textiles and Their Products	263,257	267,661	+4,404	+43,956
3. Iron and Steel and Their Products	307,167	314,093	+6,926	—129,661
4. Lumber and Its Manufacture	22,097	22,309	+212	—1,701
5. Leather and Its Finished Products	55,117	54,593	—524	+15,208
6. Paper and Printing	49,177	47,686	—1,491	—5,179
7. Liquor and Beverages	1,421	965	—456	—782
8. Chemicals and Allied Products	69,859	71,673	+1,814	—13,130
9. Stone, Clay, and Glass Products	11,770	12,782	+1,012	—2,320
10. Metal and Metal Products Other Than Steel and Iron	75,540	76,394	+854	—3,270
11. Tobacco Manufacturers	31,904	31,633	—271	+3,354
12. Vehicles for Land Transportation	174,628	174,131	—497	+80,279
13. Railroad Repair Shops	63,648	65,347	+1,699	+2,229
14. Miscellaneous Industries	267,573	267,176	—397	—73,222
Total	1,526,479	1,544,529	+18,050	—83,605

In commenting upon this increase in employment during September, Francis I. Jones, director general of the U. S. Employment Service, calls special attention to the fact that the greatest increases in employment have occurred in the western and southern sections of the country, and were obviously due to agricultural activities and the advance in the price of cotton. In the East industrial gains, he pointed out, were but slight, the most noticeable changes being in textiles, steel and iron, and the railroads. However, these favorable trends, he said, should not obscure the fact that within the next thirty days or so thousands of seasonal agricultural workers will return to industrial centers to join the multitude of unemployed unless buffer employment is furnished until they can be absorbed into their previous occupations.

A detailed study of the figures given in Table 1 will show that of the 14 industrial groups reporting, 8 showed an increase in employment in September and 6 a decrease, the iron and steel group leading those industries which reported an increase with a gain of 6926 workers, while the food and textile groups were both close seconds with gains of 4765 and 4404, respectively. Of the industries reporting a decrease in employment, the paper and printing group heads the list with a loss of 1491 workers.

The figures in the last column of Table 1, as well as the chart of Fig. 1, give perhaps a better picture of employment at the present time, as they show the net changes in the various industries with respect to January, 1921. Without attempting to go into detail, it will be seen that the iron and steel industry has suffered the greatest loss, losing 129,661 workers, while the manufacturers of vehicles for land transportation, on the other hand, have shown the greatest gain, and now have 80,267 more workers on the pay-rolls than they had in January of this year.

The figures compiled by the Employment Service are also analyzed according to their geographical distribution, and for the month of September out of the 65 cities reporting 38 have shown gains totaling 28,819, while the decrease in the remaining 26 totals 10,769, the relative ratio between the two thus being about the same as the month of August. A list of these 65 cities showing the increases and decreases in each is given on the second page following, while there follows immediately below a brief summary of the employment conditions throughout the various sections of country.

New England District (Me., N. H., Vt., Mass., R. I., and Conn.). Building in New England shows no improvement. Woolen textiles are still strong on wearing apparel, white cot-

ton standards are steady. Shoes and leather now on a 70 per cent basis are apt to go lower, this being the off season. The metal trades, generally, are very dull, with additional lay-offs. Certain lumber specialties, like boxes and shooks, are looking up.

Middle Atlantic District (N. Y., N. J., and Pa.). The first signs of general industrial improvement and occasional brighter spots in the basic steel and iron industry were reported in August. September reports indicate a continued but very gradual increase of business activity. Many cities show a greater volume of building construction at this time than for several years, but from now on there is likely to be a falling off, due to approaching bad weather. The coal mines in the western part of the district are reported to be increasing production to meet the larger volume of orders. Railroads are increasing forces gradually, especially maintenance and repair crews. Textiles and clothing industries continue slowly to approach normal.

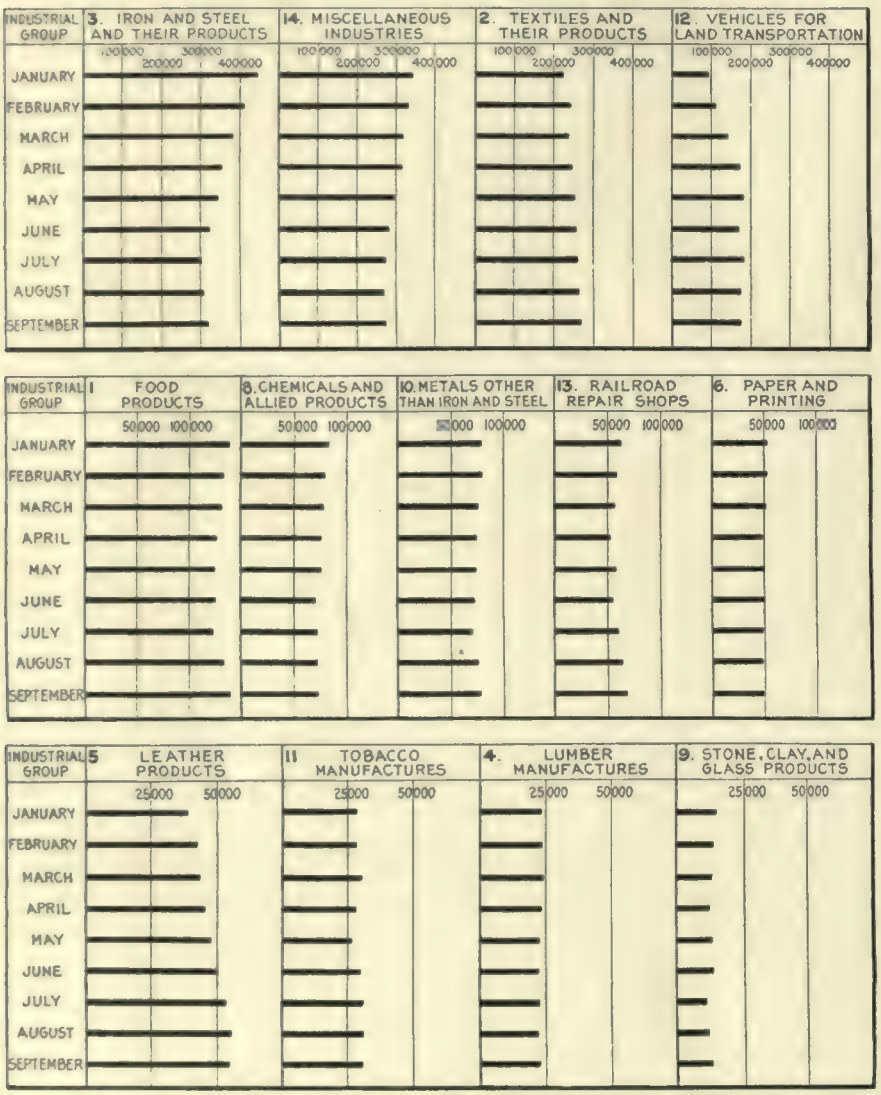


FIG. 1 HOW INDUSTRIAL EMPLOYMENT HAS VARIED SINCE JANUARY, 1921

East North Central District (Ohio, Ill., Ind., Mich., and Wis.). The iron and steel industry in this district has started to recover from its long downward trend. Production in textiles, leather, and shoes continues to improve, the level of wholesale prices showing but little change this month. Building activity and agricultural production are better than expected, and there are signs of a greater industrial activity.

West North Central District (Minn., Ia., Mo., N. D., S. D., Neb., Kan.). The past month has witnessed a general improvement throughout the district, in practically all lines except the metal and saddlery trades. Twenty-six out of thirty cities report improved retail trade. Over 71 per cent more flour has been manufactured in the past 60 days than in the same period last year. The metal trades continue very quiet. A survey of 101 plants in the St. Louis district shows only 47 per cent employed against the same time last year and of these 25 per cent are working only part time. While in general Kansas is busy and showing real prosperity, in the oil fields 60 per cent of the workers are idle, and in zinc mining 1500 are idle. A survey made recently by State authorities shows that the total unemployment approximates 15,000.

South Atlantic District (Del., Md., D. C., Va., W. Va., N. C., S. C., Ga., and Fla.). Reports from all sources, and covering all industries in this district, show decided improvement. A steadily increasing number of textile mills report larger figures of employment while operators expect good business for the next two or three months, but they are not especially optimistic as to a continued increase in business. In Georgia, North Carolina, South Carolina, and Florida, 111 concerns manufacturing lumber products, employing 10,266, show a net gain of 634 for the month. In Virginia, 30 coal operators show a total employment on September 15 of 7097, with a net gain of 105 for the month. The consensus of opinion among operators is that there should be continuing improvement in coal mining. Unemployment continues throughout the district, however, in iron and steel particularly, also in unskilled labor, in shipbuilding and waterfront workers. The increased price of cotton has resulted in the settlement of many accounts in the South and has restored that section of the country to a position of active buying.

East South Central District (Ky., Tenn., Ala., and Miss.). Present conditions in the coal mining region of Tennessee and southeastern Kentucky show more men idle than any previous month. Mines now idle usually employ from 5000 to 6000 men. Apparently there is no prospect of early improvement. In the western Kentucky field, however, several mines have reopened and the outlook is more hopeful. Conditions covering lumber products plants show very marked improvement, which will result in practically full time and full employment in the southern pine mills, both in Alabama and Mississippi. Mills which have been shut down for several months are reopening with full forces. It is estimated that several thousand men will be employed as a result of the increased operations.

West South Central District (Ark., La., Okla., and Tex.). While there continues to be much unemployment and part time throughout the district, the general economic situation has improved, due largely to the increase in the price of cotton. Bank loans are being liquidated and deposits are greater. The Southern Pine Association reports a much heavier demand for pine lumber, with production increasing. Improvement has been noted in glass, packing houses, railroad repair shops, and flour mills.

Mountain District (Mont., Idaho, Wyo., Colo., N. M., Utah, Ariz., and Nev.). Although a moderate gain in general employment is noticeable, it is to a large extent directly traceable to agricultural activities. While slightly better conditions exist in the coal mining districts, other industrials, notably those connected with metal mining and manufacturing, report a decline. Railroad activities in several localities are picking up.

Pacific Division (Wash., Ore., and Cal.). Seasonal activities are responsible for a slight reduction in unemployment in this

district. Industry in general, however, is still below normal. Building industry is fairly active, but farm labor demand shows no increase over last month. Fruit picking and canning are now at the height of season, and canneries are operating at about 60 per cent of capacity.

Cities Reporting An Increase in Employment in September, 1921		Cities Reporting a Decrease in Employment in September, 1921	
Toledo, Ohio	2307	Providence, R. I.	699
Portland, Ore	1387	Camden, N. J.	1171
Baltimore, Md.	2741	Niagara Falls, N. Y.	163
Kansas City, Kan.	602	Brockton, Mass.	504
Memphis, Tenn.	304	Newark, N. J.	1194
Minneapolis, Minn.	990	Albany-Schenectady, N.Y.	639
Pittsburgh, Pa.	4953	New Haven, Conn.	267
Youngstown, Ohio.	1693	New York, N. Y.	3193
Kansas City, Mo.	569	Atlanta, Ga.	141
Buffalo, N. Y.	1734	Indianapolis, Ind.	202
Peoria, Ill.	166	St. Louis, Mo.	247
Johnstown, Pa.	698	Rochester, N. Y.	390
Grand Rapids, Mich.	307	Passaic, N. J.	157
Jersey City, N. J.	603	Syracuse, N. Y.	100
Birmingham, Ala.	945	Paterson, N. J.	67
Yonkers, N. Y.	529	Bayonne, N. J.	73
Springfield, Mass.	831	Manchester, N. Y.	165
San Francisco, Cal.	219	New Orleans, La.	48
St. Paul, Minn.	351	Perth Amboy, N. J.	78
Reading, Pa.	600	Fall River, Mass.	197
New Bedford, Mass.	1013	Trenton, N. J.	63
Louisville, Ky.	188	Detroit, Mich.	734
Flint, Mich.	559	Boston, Mass.	210
Los Angeles, Cal.	571	Omaha, Nebr.	36
Cincinnati, Ohio.	267	Milwaukee, Wisc.	29
Dayton, Ohio	222	Richmond Va.	2
Lawrence, Mass.	513		
Bridgeport, Conn.	257		
Waterbury, Conn.	142		
Chicago, Ill.	1953		
Cleveland, Ohio.	250		
Total of 7 cities reporting less than 100 each.	355		
Total Increase in 38 Cities	28,819	Total Decrease in 26 Cities	10,769

Cost of Living *331.2*

The Cost of Living Slightly Lower

THE cost of living in the United States dropped but a fraction of a per cent during September, and is still approximately 70 per cent above the pre-war levels of 1914, according to data gathered by both the U. S. Bureau of Labor Statistics and by the National Industrial Conference Board (New York). The figures of the Bureau show that living costs are now 77.3 per cent above those of 1913, while the figures compiled by the Conference Board are somewhat lower, being at the end of September 63.7 per cent. The details of the two compilations showing the fluctuation during the month in the various items which go to make up the average family budget are given in Table 2, while the trend of the cost of living since 1914, as reported by both agencies, is shown by the two heavy curves of Fig. 2. In the same figure the dotted curves gives the variations

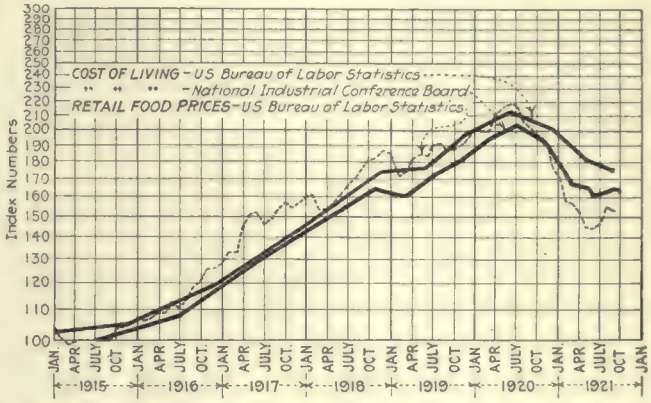


FIG. 2 THE TREND OF THE COST OF LIVING IN THE UNITED STATES SINCE 1914

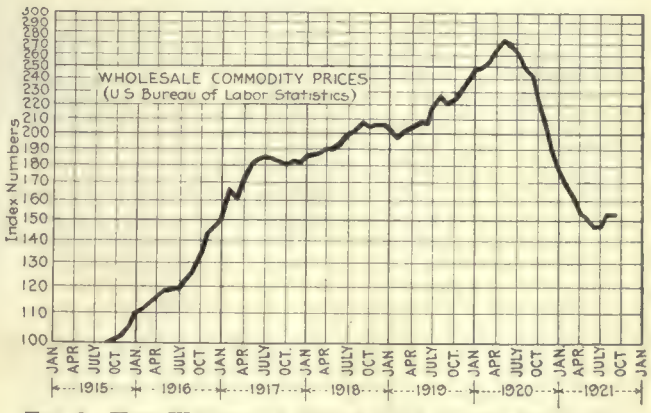


FIG. 3 HOW WHOLESALE PRICES HAVE VARIED SINCE 1914

TABLE 2. PER CENT CHANGES IN THE COST OF LIVING IN THE UNITED STATES IN SEPTEMBER, 1921

Item	National Industrial Conference Board			U. S. Bureau of Labor Statistics		
	Relative Importance in Family Budget Per Cent.	Per Cent Increase above Average Prices in July 1914 and		Relative Importance in Family Budget Per Cent.	Per Cent Increase above Average Prices in 1913 and	
		Sept. 1921	Oct. 1921		May 1921	Sept. 1921
Food	43.1	55*	53*	38.2	44.7	53.1
Shelter	17.7	69	69	16.6	122.6	92.1
Clothing	13.2	57	60	13.4	59.0	60.0
Fuel and Light.	5.6	79	79	5.3	81.6	80.7
Furniture and Furnishings.	....	....	....	5.1	147.7	124.7
Sundries	20.4	83	80	21.3	108.8	107.7
Weighted average of all items	100.0	64.8	63.7	100.0	80.4	77.3

* Food price figures are for the 15th of the preceding month, from the United States Bureau of Labor Statistics.

TABLE 3. INDEX NUMBERS OF WHOLESALE PRICES, BY GROUPS OF COMMODITIES FOR AUGUST AND SEPTEMBER, 1921.

(Compiled by the United States Bureau of Labor Statistics. Base Year 1913 = 100)

Commodity Group	1921		1920
	Aug.	Sept.	Sept.
Farm products	118	122	210
Food, etc.	152	146	223
Cloths and clothing	179	187	278
Fuel and lighting	182	178	284
Metals and metal products	120	120	192
Building materials	198	193	318
Chemicals and drugs	161	162	222
House-furnishing goods	230	223	371
Miscellaneous	147	146	239
All Commodities	152	152	242

in the retail prices of foods, this curve in itself being a fairly reliable guide to the cost of living, as about 40 per cent of the average family budget goes for this item, the National Industrial Conference Board weighing at as 43.1 per cent, while the U. S. Bureau of Labor Statistics gives it a weighing in their budget of 38.2 per cent.

As a further indication of the trend of the cost of living, Fig. 3 and Table 3 are presented. Fig. 3 shows the trend of wholesale prices for all commodities as reported by the U. S. Bureau of Labor Statistics since 1914, while Table 3 shows the changes from August to September in the individual groups of commodities. As shown by both table and chart, changes in wholesale prices during the month were slight, but a marked change has occurred since the peak was reached in May, 1920.

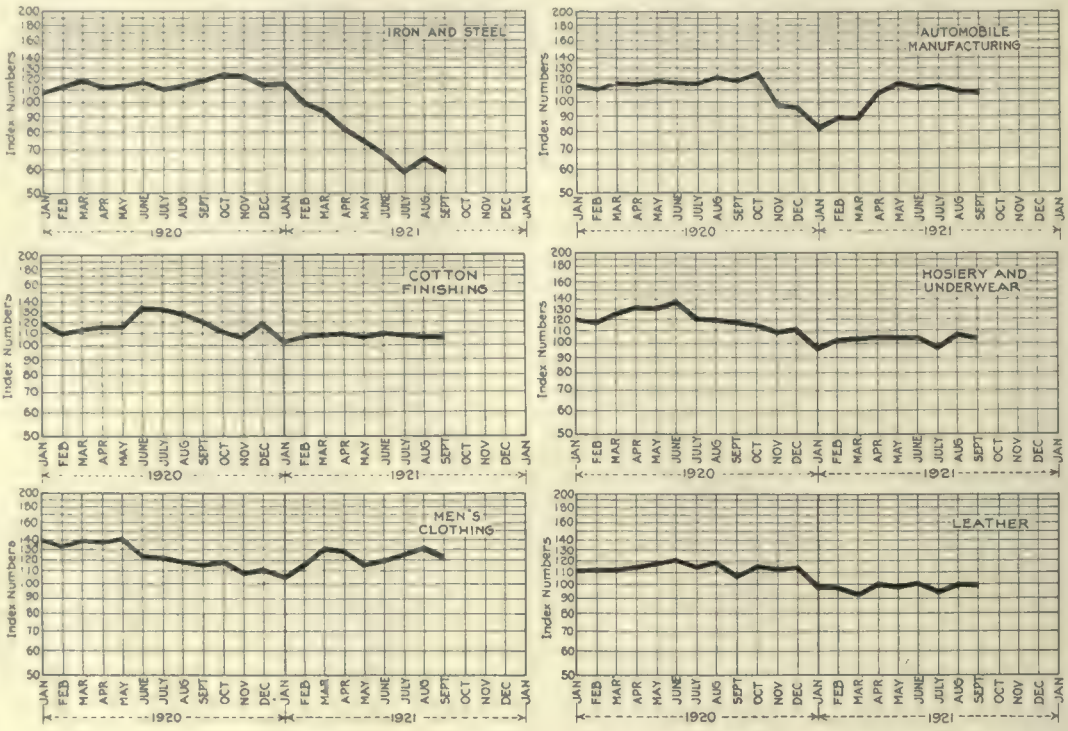


FIG. 4 THE TREND OF WAGES IN

Wages *331.2*

Industrial Earnings Decline in September

FIGURES made available by the U. S. Bureau of Labor Statistics, giving the changes in wage rates and the per capita earnings in some 14 industries of the country, show that the trend of industrial wages during the month of September was downward. A condensed presentation of the figures compiled by the Bureau is given in Table 4, the average earnings reported for the two months of August and September bing obtained by dividing the total amount of the payroll for any one industry by the total number of employees on the payrolls in the industry during that particular month. The index numbers given in the last two columns of the table are computed, using earnings during the year 1919 as equal to 100.

As shown by the table, the average earnings decrease in all industries except cotton manufacturing and cotton finishing, no marked increase, however, occuring in either. Changes in per capita earnings since January, 1920, are shown for the industries listed in Table 4 in the charts of Fig. 4, while there follows below a brief abstract of the Bureau reports on wage changes during the month of September.

Iron and Steel. One establishment in the iron and steel industry made a wage rate reduction of 40 per cent to 61 per cent of the employees, and one of 16 per cent to 39 per cent of the employees. The entire force of another establishment was reduced 31 per cent in wages. Decreases ranging from 27 to 32 per cent were reported by one mill, affecting all men. One-third of the force in one concern had a wage reduction of 22½ per cent. A decrease of 20 per cent was reported by four plants, affecting all the men in the first two plants, 50 per cent of the men in the second plant and 10 per cent of the men in the third plant. Seven mills reported a decrease in wage rates of 19 per cent, which affected all employees. Three mills reported a wage reduction of 15 per cent, affecting about 62 per cent of the force in the first mill, 50 per cent of the force in the second mill; but the percentage affected in the third mill was not stated. Many mills in the iron and steel industry are temporarily idle, and on account of irregular operation the per capita earnings decreased 7.6 per cent from August to September.

TABLE 4. AVERAGE EARNING IN SELECTED INDUSTRIES DURING AUGUST AND SEPTEMBER, 1921.

(Based on Figures Compiled by the U. S. Bureau of Labor Statistics. Base Year 1919 = 100)

Industry	Period of Pay-Roll	Average Earning During		Index Numbers	
		Aug. 1921	Sept. 1921	Aug. 1921	Sept. 1921
Iron and steel	½ mo.	$42.50	$38.80	65	59
Automobiles	1 wk.	32.00	31.40	109	107
Car-building and repairing	½ mo.	60.40	58.50	107	104
Cotton manufacturing	1 wk.	16.40	16.90	98	100
Cotton finishing	"	21.70	22.00	106	107
Hosiery and underwear	"	17.00	16.40	107	103
Woolens	"	22.40	22.40	112	112
Silk	2 wks.	43.00	41.70	117	114
Men's clothing	1 wk.	33.40	31.60	130	123
Leather	"	22.80	22.60	99	98
Boots and shoes	"	24.15	22.80	112	106
Paper making	"	24.70	23.60	109	104
Cigar manufacturing	"	19.10	19.00	111	110

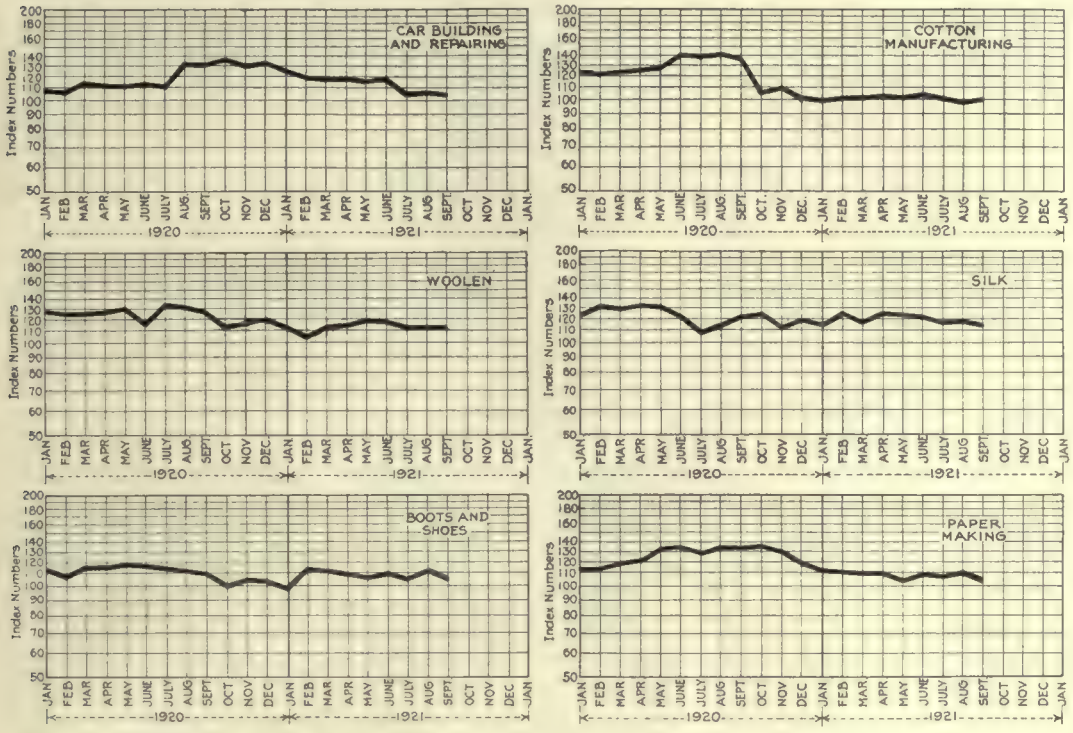
Automobiles. A decrease of 10 per cent was reported by 6 establishments, affecting all of the men in one establishment, 75 per cent in the second, 60 per cent in the third, 50 per cent in the fourth and fifth, and 10 per cent in the sixth. In one shop decreases ranging from 8 to 10 per cent were made to 75 per cent of the force. The wages of 47 per cent of the force of one plant were reduced 8 per cent. The shop force was reduced 8 cents per hour and the office force 5 per cent in one plant. When comparing the per capita earnings for September with those for August, a decrease of 4.3 per cent is noted.

Car Building and Repairing. Three establishments reported a 15 per cent wage decrease, affecting 75 per cent of the men. A decrease of 13 per cent to 3 per cent of the employees was reported by one shop. A reduction of 9 per cent in wages was made to 3 per cent of the force in another shop. Throughout this industry there was a general decrease in the number of hours worked. The per capita earnings for September are 4 per cent less than those for August.

Cotton Manufacturing. In one establishment a 10 per cent decrease in wage rates was made to 95 per cent of the force. Establishments in this industry report a slight increase in volume of employment due to resuming full time operations. When comparing the per capita earnings for August and September an increase of 1.5 per cent is shown.

Hosiery and Underwear. All employees in concern were granted an increase of 15 per cent. A decrease of 15 per cent to 40 per cent of the men was reported by one establishment. A wage reduction of 8¾ per cent was made by one mill affecting 3½ per cent of the force. In one plant an average monthly bonus of 8 per cent, which had been given to 95 per cent of the force, was discontinued. The per capita earnings for September are 1.4 per cent higher than those for August.

Woolen. The figures for September show little change from those for August. The per capita earnings are 0.2 per cent greater than in August.



AMERICAN INDUSTRIES SINCE JANUARY, 1921

Silk. A wage rate decrease of 10 per cent, affecting 50 per cent of the employees, was made by one mill. Less time was worked throughout the industry as trade was slack during this period. When comparing the per capita earnings for August and September a decrease of 5.1 per cent appears.

Leather. All employees in one plant were granted an increase of 12½ per cent. The day workers in one firm were reduced 12½ per cent in wages while the pieceworkers had decreases ranging from 20 to 30 per cent. The entire force of another tannery had a wage reduction of 10 per cent. The per capita earnings for September show a decrease over August of 2.3 per cent.

Index Numbers *338(026)*

Industrial Index Numbers

IN the October issue MANAGEMENT ENGINEERING presented a series of tables and charts showing trends in industrial movements since January, 1920. A similar set of charts and tables showing trends for July and August is given on the two pages which follow, these being, however, but part of a more complete and exhaustive report issued by the Dpartmnt of Commerce under the title of "The Survey of Current Business," which covers not only the movements in industry but also of agriculture, foreign trade, banking and finance, and retail movements. The data thus issued by the Bureau are gathered from many sources, such as the various bureaus of the Government, trade associations, trade journals, etc., the value of the compilation being in the fact that there is thus brought together in one place considerable important statistical data formerly widely scattered. Limitations of space will not permit of a detailed analysis of the tables and charts presented, but attention is directed towards the fact that in the majority of cases the relative index numbers are computed on a basis of the average of the year 1913 as equal to 100. In some instances, however, the basic statistical data do not go back to pre-war years, and in such cases averages for the year 1919 have been employed as a base. In still a few other instances special base years have been employed. In all cases, however, the base year used is clearly indicated by footnotes to the tables.

TABLE 1. RUBBER

Item	Numerical Data		Base Year	Index Numbers	
	July 1921	August 1921		July 1921	August 1921
IMPORTS: Crude, lb. (Dept. of Com.)	27,647,874	33,103,804	1913	286	343
Consumption By Tire Manufacturers, lbs.	23,719,639	.....	a1920	361	....
AUTOMOBILE TIRE PRODUCTION: (Rubber Assoc. of America)					
Pneumatic Tires	2,570,524	.. ...	a1920	396	....
Solid Tires	35,123	.. ...	a1920	164	....
Inner Tubes	3,020,981	.. ..	a1920	407	....
AUTOMOBILE TIRE STOCKS: (Rubber Assoc. of America)					
Pneumatic Tires	3,892,037	.....	a1920	66	....
Solid Tires	220,003	.....	a1920	74	....
Inner Tubes	3,122,815	.....	a1920	51	....

a November.

TABLE 2. LEATHER PRODUCTS

Item	Numerical Data		Base Year	Index Numbers	
	July 1921	August 1921		July 1921	August 1921
PRODUCTION:					
Sole Leather, Sides (Tanners' Council)	1,431,373	1,607,302	1919	76	86
Oak and Union Harness; Stuffed Sides (Tanners' Council)	44,971	48,286	1919	47	51
Finished Sole and Belting, lb. (Dept. of Com.)	25,028,000	.....	c1920	104	....
Finished Harness Case Welding etc., lb. (Dept. of Com.)	2,543,000	.... .	c1920	65	....
CONSUMPTION:					
Sole and Belting, lb. (Dept. of Com)	17,779,000	.....	c1920	122	....
Harness Welting, lb. (Dept. of Com.)	1,516,000	.. . .	c1920	122	.. .
STOCKS AT END OF MONTH:					
Sole and Belting, lb. (Dept. of Com.)	197,616,000	.... .	c1920	130	....
Harness Welting, lb. (Dept. of Com.)	18,980,000	.....	c1920	133	....

c September.

TABLE 3 FUEL AND POWER

Item	Numerical Data		Base Year	Index Numbers	
	July 1921	August 1921		July 1921	August 1921
COAL AND COKE PRODUCTION: (Dept. of Int.)					
Bituminous Coal, Net Tons	30,394,000	34,538,000	1913	76	87
Anthracite Coal, Net Tons	7,050,000	7,196,000	1913	92	94
Beehive Coke, Net Tons	181,000	248,000	1913	6	9
By-Product Coke, Net Tons	1,285	1,402,000	1913	121	132
PETROLEUM AND GASOLINE (Dept. of Int.)					
Crude Petroleum; Production, bbl	40,328,000	40,964,000	1913	195	198
Stocks, bbl	167,352,000	168,023,000	1913	159	160
Consumption, bbl	41,533,000	42,760,000	1913	190	196
Gasoline; Production, gal	419,642,000	. . .	1919	127	....
Domestic Consumption, gal	457,758,000	.....	1919	160	.. .
Stocks at End of Month, gal	684,237,000	.. ...	1919	145	....
ELECTRIC POWER PRODUCTION: Public Utility Plants, kw-hr. (000 omitted) (Dept. of Int.)	3,269,971	.....	1919	101	....

TABLE 4. PAPER

Item	Numerical Data		Base Year	Index Numbers	
	July 1921	August 1921		July 1921	August 1921
PRODUCTION: (Fed. Trade Com.)					
Newsprint Paper, Tons	94,247	102,277	1919	82	89
All Other Paper, Tons	276,182	304,242	1919	69	85
STOCKS: (Fed. Trade Com.)					
Newsprint Paper, Tons	25,519	27,128	1919	107	113
All Other Paper, Tons	254,025	246,881	1919	118	115

TABLE 5. TRANSPORTATION

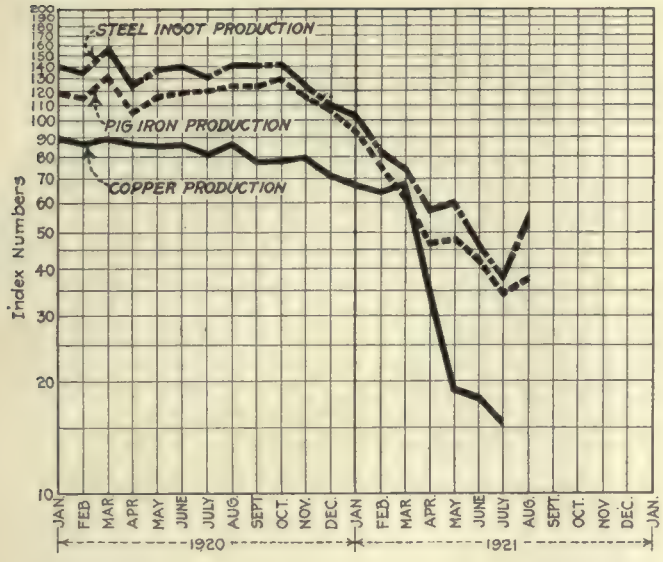
Item	Numerical Data		Base Year	Index Numbers	
	July 1921	August 1921		July 1921	August 1921
FREIGHT CAR SURPLUS: (Amer. Ry. Assoc.)					
Box	93,013	69,013	1919	113	84
Coal	161,723	130,596	1919	214	173
Total[1]	321,781	246,740	1919	170	130
FREIGHT CAR SHORTAGE:					
Box	3,710	641	1919	20	3
Coal	83	67	1919	2	2
Total[1]	3,905	739	1919	16	3
CAR LOADINGS, Total[2]	750,717	812,265	1919	94	101

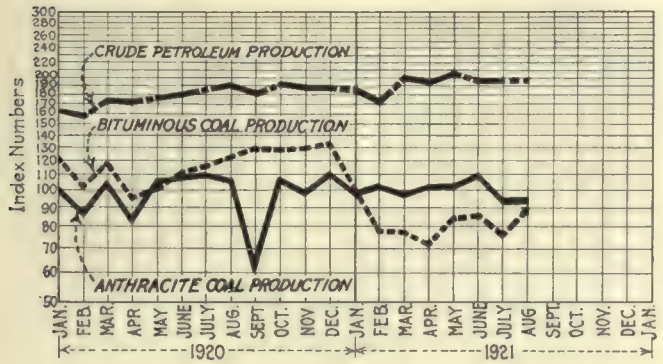
[1] Includes other classes than group listed.
[2] Total includes coke shipments in addition to commodity groups listed.

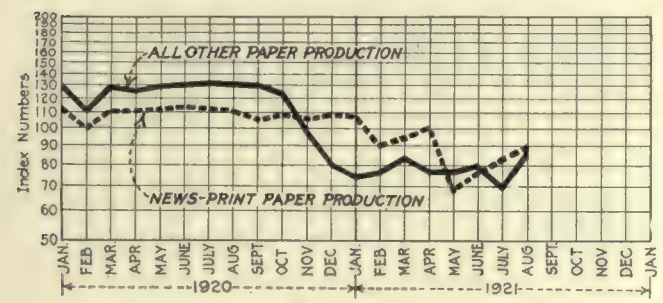
TABLE 6. TEXTILES

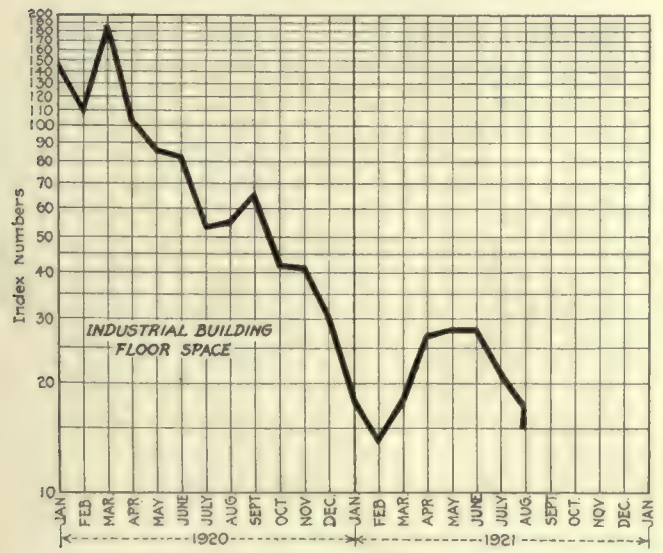
Item	Numerical Data		Base Year	Index Numbers[1]	
	July 1921	August 1921		July 1921	August 1921
WOOL:					
Consumption, lb. Increase Equivalent (Dept. of Agri.)	53,346,000	.....	1913	132	....
Number of Active Spindles (Dept. of Com.)					
Woolen	1,829,000	1,802,000	....	(80)	(79)
Worsted	2,132,000	2,052,000	....	(90)	(87)
Number of Active Looms (Dept. of Com.)					
Wide	51,008,000	49,413,000	....	(80)	(80)
Narrow	13,776,000	13,330,000	....	(75)	(74)
Carpet	4,230,000	4,273,000	....	(49)	(50)
COTTON:					
Consumption, Bales, (Dept. of Com.)	410,120	467,103	1913	85	97
Stocks on Hand in Mills, Bales, (Dept. of Com.)	1,115,847	1,002,981	1913	83	75
Stocks, Warehouse, Bales, (Dept. of Com.)	3,724,512	3,480,783	1913	212	198
Number of Active Spindles (Dept. of Com.)	32,446,000	33,059,000	1913	107	109
Fabric Consumed by Tire Manufacturers, lb. (Rubber Assoc. of America)	956,508	.....	a1920	531	....
SILK:					
Consumption, Raw Bales (Silk Assoc. of America)	32,325	32,790	1913	107	109
Stocks at End of Month, Raw Bales (Silk Association of America)	17,886	18,866	b1920	28	29
TEXTILE MANUFACTURERS: Production Underwear (Dozen) (Knitgoods Mfrs. of America)	490,640	.....	....	(51)	....

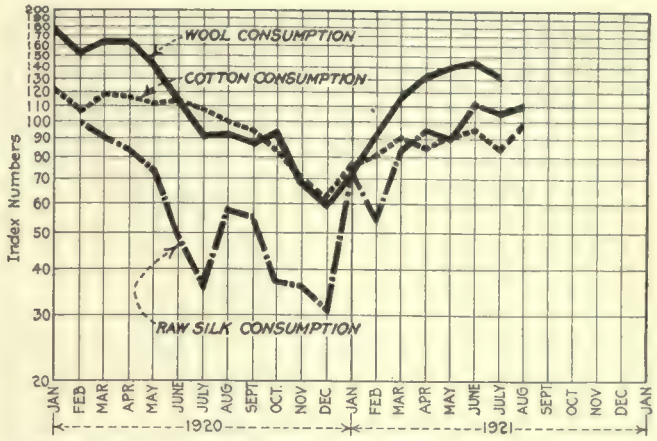
[1] Figures in parentheses are per cents, not index numbers.
a November.
b February.

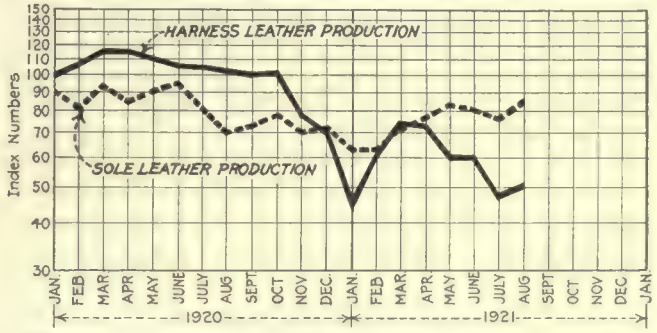


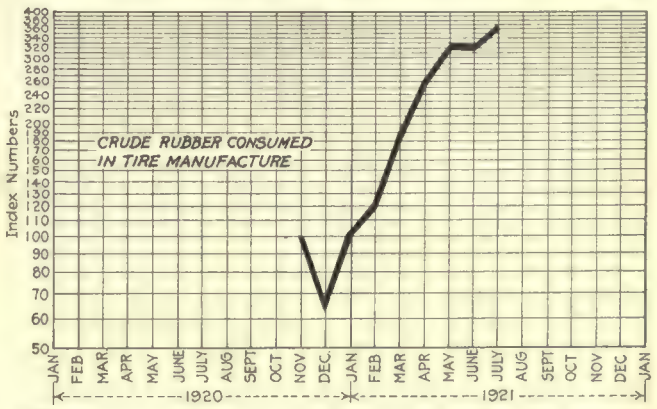












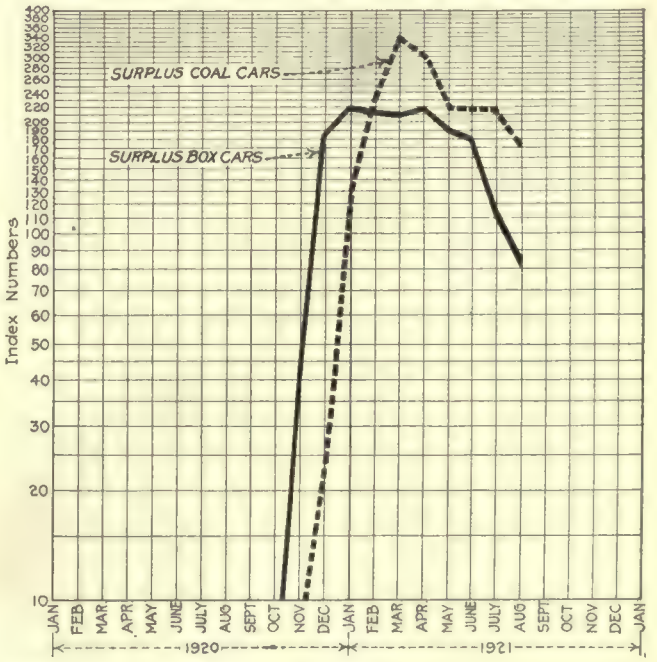


FIG. 6 THE TREND OF INDUSTRIAL MOVEMENTS SINCE JANUARY, 1920

MANAGEMENT ENGINEERING

THE JOURNAL OF PRODUCTION

L. P. ALFORD, *Editor*
E. W. TREE, *Associate Editor*

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The Common Factor

DO you think of your work as different? Do you believe that you can learn nothing from another industry and but little from other men in your own? If you think or believe in this way you are wrong. All those who imagine there are no factors common to all industries are deceiving themselves.

Such errors in ideas are the children of trade secrets. Time was when every shop guarded everything that it had and knew. Early steam engines were set up and run behind locked doors. Machines were designed and built in out of the way places. Processes were safeguarded as carefully as the bankroll. Many times a certain formula for a compound or material was known to but one man. Competitors were excluded. On the other hand, ingenuity was used in trying to pry into competitors' plants, processes, and machinery.

Thank Heaven, this condition is pretty well gone in American industry! Automobile building is the outstanding success of the no-trade-secrets policy.

But though the attitude to "let the other fellow have a look-in" prevails and many are ready to "look over" a plant in their own line, far too few are willing to learn from the outside. The executive in a plant making silk stockings keeps away from shoeshops. The wood-working superintendent or foreman shuns the machine shop; the textile agent or overseer would not think of entering a foundry. And so it goes.

This unwillingness to venture outside of one's particular interest is all wrong. Industry has many common factors—particularly those of management. Every industry has factory buildings with the same kind of general equipment and a power supply, methods for standardizing and maintaining equipment, storerooms for raw material and finished product, planning methods and routing, equipment for handling and moving material, control for production and quality, methods and devices for time, motion, and operation studies, time-keeping and wage-payment systems, cost accounting, maintenance of labor—to say nothing of the organization itself.

In no one place, in no one industry are all of these factors developed to the highest effectiveness. To gain a knowledge of the best-known practice, principles, facts, and experience must be drawn from many sources. All this, management is endeavoring to do.

If you would keep abreast of industrial progress, if you would better prepare yourself for your present job and another that may be in prospect you must make management one of your principal studies.

The old adage "Knowledge is power" is still true.

In some parts of New England, particularly Massachusetts, there is a shortage of women workers for industry. The engineer for a group of knitting mills reports that they could use 500 more girls if they could hire them. A metal working plant recently advertised for 250 girls; two rubber plants report a shortage.

At the same time it is estimated that there are 300,000 men out of work in Massachusetts alone.

Why the contrast?

Is this the beginning of a situation that will spread throughout all our industrial communities as business revives? Women who entered occupations formerly filled by men are staying there. They have no inclination to go back to women's occupations because these are lower paid. Employers are willing that they should continue in men's places for their wages, though higher than those in women's occupations, are lower than those which would be paid to the men who might replace them.

Time will show what readjustment must be made, but the women seem to be holding the frontiers of industry which they secured during the war. It may be that they will never give up these positions, for since 1912 they have won the right to study what and where they please, and since 1919 the right to vote and to hold office, and these three gains seem to be all in the same direction.

The Unemployment Conference

THE Unemployment Conference began its work with general good wishes but with a fear as to the practical work that might be accomplished. If you want to make a certain product you begin to design and build your plant and equipment months, if not years, before you ship output. You preplan a long time in advance.

To handle the present unemployment situation adequately we should have started to build a machine for the purpose, say, 10 years ago. So it hardly seemed possible that the conference could do much in the present situation except suggest emergency measures, and then plan steps which, if taken, would permit us to handle a similar situation, say in 1930, with effectiveness. This forecast seems to have become a reality and in nowise lessens the value of the work of the conference as a whole.

One outstanding reason for the success of the Conference was the work of the Economic Advisory Com-

mittee composed of economists and engineers. These men gathered and compiled facts in usable form, brought to bear upon the problems involved a maximum of experience, and supplied the very element which might naturally have been expected to be absent in a body called together upon such short notice.

The emergency measures are addressed to localities. Mayors of cities are urged to begin all new work possible, to establish employment agencies, and to stimulate the giving of employment in their communities. Governors are urged to co-ordinate the efforts of the mayors and employment committees, to undertake state work, and to improve matters wherever possible. Encouragement is given to the building industry which it is estimated should absorb two million men.

Turning to manufacturing the committee minces no words in condemning continued efforts to secure unwarranted profits. It urges manufacturers, wholesalers, and retailers to adjust prices to reflect lowered production costs.

None of the recommendations are revolutionary. On the contrary, they seem practical and have been arrived at with a dispatch and unanimity of opinion which is gratifying. But while these are being put into effect we must not lose sight of the necessity of building an employment machine designed for permanent use, to serve during the forthcoming years of prosperity, and to be in readiness when the next period of widespread unemployment comes.

"The curse of mankind is not labour, but *WASTE;* misdirection of time, of material, of opportunity, of humanity." M. O. Forrester (President, Chemical Section, British Association for the Advancement of Science).

"Mistakes? Hell, yes. We made them. They were expected to be made. We were trying to win the war, but this committee should turn its attention to the elimination of those millions of waste right under your noses instead of trying to put fly specks on the American Army."—General C. G. Dawes (from testimony before a Congressional committee.)

Rebuilding the I. R. A. A.

THE business session to be held at the forthcoming meeting of the Industrial Relations Association of America promises to mark a turning point in the affairs of that organization.

Brought into being in the spring of 1918, under the shadow of the war, it has had a career paralleling in many ways that of other struggling associations; now, under the pressure of new conditions, its future must be definitely planned. All of this is clearly seen by those who are responsible for the direction of its affairs, but at the moment unanimity of opinion in regard to the wise course to follow has hardly been reached, though the outlook is hopeful.

When originally organized, under the name of the Employment Managers' Association, it was a loose federation of local employment managers' societies. It is still such a mixed federation, although a number of changes have been made in details of its organization and direction including the abandoning of the original name and the adoption of the present one.

The opposed lines of thinking in regard to reorganization seem to be these: the one is that the present type of federation should be maintained; the other is that the organization should be completely reconstituted on a basis of individual membership instead of society membership.

The second proposition is directly in line with the plan which has been so successful in the societies and associations of engineers in this country. Thus at the outset, the advocates of this plan have a strong background of experience upon which to build their case.

In addition they have a group of experimental facts which is hard to overargue.

At the moment there are 35 local employment groups having membership in the national association. During this year two have withdrawn. In all there are 67 such organized local groups in the United States. So the national organization has been able to attract only about one-half of the possible into its membership. The number of individuals having an interest in the national association through membership in locals is some 1,500 to 1,700. There are at least 5,000 men and women in this country who would be eligible for membership in a national society on an individual membership basis.

The financial argument is even stronger in favor of individual membership. During the last eight or nine months the association has struggled to make up a deficit, and at the moment is some $3500 in debt. Its income per member of its local societies is about $4.50 per year. The local organization fee for a membership of 75 or less is on a basis of $100 per year minimum, and $300 maximum. The fee payable for societies having 76 or more members is $4 per member per year. In contrast the incomes per member from the engineering societies which draw their membership from industries are in round figures as follows:

American Society of Mechanical Engineers	$37
Society of Industrial Engineers	$21
The Taylor Society	$19

There is a big difference between the $4.50 per member of the I. R. A. A. and the unit incomes in the engineering group.

Any association or society like the I. R. A. A. exists to help and serve its members. On the individual membership basis not only would the interest of the members be keener than through any type of local organization membership but with the increase in income promised it would be possible to render far greater service. It is evident that this is needed. A few features which might be strengthening or initiated are: the collection and compilation in usable form of essential data on industrial relations work, the establishment of an information service on industrial relations, the publica-

tion of a journal to give current news and information of general interest, the development of a placement service as a point of contact between employers and applicants for positions, the conducting of a series of state or regional conferences on industrial relations and a strengthening of the national conventions.

It will be a source of regret, if not almost a catastrophe, if progressive ideas do not prevail in this plan of reorganization. Seemingly, those who believe in the reconstruction of the association on the basis of individual membership with several grades of members to meet the need of all who are interested in employment and personnel work, have the stronger reasons to support their position.

"The legitimate scientific dreams of today are the successful technical processes of tomorrow."—Charles Baskerville.

The Measurement of Management

MEASUREMENT is the starting point of permanent progress in both the arts and pure science. G. S. Radford has given renewed recognition to this fact in his "Measurement and Errors in Manufacturing" in this issue. He shows that there are three steps in measurement: Selection of the characteristics which we wish to become standard—embodied in manufacturing in a standard sample; then the selection of a method of comparison; and finally, the development of instrumental means for making comparisons.

These three steps apply in the measurement of management just as truly as in the measurement of articles of manufacture, although the standard characteristics, the units of measurement and the instrumental means, may be far different from those employed in measuring physical objects. In spite of the fact that no comprehensive study has been made by any engineer or group of engineers of this subject, yet from the inception of management attempts have been made to measure some of its factors. The earliest example is the time-study work of Frederick W. Taylor. He developed methods and means for the measurement of the time required to perform operations and showed how to standardize machine characteristics, tools, feeds, and speeds.

The work of others has given us means for measuring the motions involved in performing industrial operations, idleness of men and of machines, labor turnover, unemployment, waste in industry, and industrial accidents. On page 141, of the September issue of MANAGEMENT ENGINEERING, A. L. De Leeuw presented a method for measuring the final efficiency of an industrial plant or a department thereof.

It may be thought that these attempts should not properly be classed as measurement for the reason that admittedly they deal with factors incapable of precise determination. Such thinking loses sight of the fact that the art of measurement is constantly progressing and that while we have devices in use in our shops today which are accurate within themselves to within 0.000005 of an inch, yet less than a score of years ago it was common to hear dimensions given as "2 3/64 in. *scant,*" "4½ in. *full.*" In fact, the units of measurement and instruments now available for everyday shopwork are essentially more accurate than those used in laboratory investigations by the past generation.

From another point of view many engineering measurements which are quite necessary and perfectly satisfactory are of a different order of accuracy. A huge reservoir is planned to contain a certain number of millions of gallons of water. It is built, filled, and the reservoir fulfils its function, but who knows how many gallons are actually stored? Plans for the development of a mine are based upon an engineer's estimate of quantity and richness of the ore body, but such an estimate is not of the order of the measurement made with an error which does not exceed 0.000005 of an inch. Again, the weight of a proposed battleship is carefully estimated as the plans are drawn, but who knows what the battleship actually weighs when completed, and what difference does it make if the estimate is approximately true?

It is reasonable to believe that the degree of accuracy of measurement already employed for some management factors is of as high an order as that prevailing in many other engineering determinations. If this is true in the beginning of this branch of mensuration, may we not confidently expect decided progress as more study and experiment lead on to major improvements?

What has been done must be recognized as but a beginning for it is easy to list factor after factor in management for which we have no standard characteristics or units of measurement or instrumental means. To indicate but a few, we do not know how to measure the maintenance of equipment, the adaptability of a plant, the effectiveness of store-keeping, tool-keeping, and of tool supply, the efficiency of equipment, the effectiveness of utilization of materials, the effectiveness of records, the completeness of technical knowledge, and many others.

Yet no one would venture the opinion that these factors cannot be measured just as truly as those for which we have already standard characteristics, and acceptable means.

No aspect of management engineering holds such a promise and opportunity for worth-while work as this of measurement. As soon as we are able to evaluate in quantitative terms we will destroy the intangible character of much of the work now being done, and lay the engineering foundation for that progress in the effective utilization of materials, time, and human effort which is so necessary for the upbuilding of American industry.

CATALYTIC ACTION—DISCUSSION

By H. L. BULLOCK

The Celluloid Company

On page 250 of MANAGEMENT ENGINEERING for October you mention the *New York Times* editorial treatment of the paper on Catalysis delivered by W. D.

Bancroft, Professor of Physical Chemistry at Cornell University. The wording, "without self-change or exhaustion," seems to bother you. You propound the double question of its being a new arrival or rejuvenated perpetual motion. Catalytic action is neither of these. It is not a new arrival, having been used commercially by Knietsch in 1901 in the preparation of sulphur trioxide. It is not even a distant relative of perpetual motion, and would not be confused with it by anyone possessing any chemical knowledge. In all chemical reactions there is a point of equilibrium which limits the commercial yield of the process. A ctatlytic agent "without self-change or exhaustion" displaces this point of equilibrium. When the displacement is in the direction of higher yield the catalytis becomes an economic factor of importance.

Reid of Johns Hopkins University has produced a 10 per cent higher yield of ethyl acetate than corresponds to the theoretical equation by the use of silica gel as a catalytic agent.

As mentioned in the October issue of *Mechanical Engineering* the discovery of a catalytic agent which would give a displacement of 10 per cent in the right direction in the synthesis of ammonia would be revolutionary.

BOOK REVIEWS

Psychology and industrial efficiency *658 : 15*

THE PSYCHOLOGY OF INDUSTRY

By James Drever

Publisher, E. P. Dutton and Company, New York

REVIEWED BY HARRY W. KIMBALL

President, Rhode Island Industrial Relation Association

WHEN Professor Munsterberg in 1913 published his "Psychology and Industrial Efficiency," he initiated a long series of books on the relations of psychology to industry of which the present work is one of the latest. It does not pretend to be an original contribution to the subject under discussion, but simply aims to bring together some of the conclusions which original investigators have reached. As a handbook on mental engineering it will prove valuable to the English readers for whom it was originally intended, but in this country much more serviceable books have already been published. The use of psychology in industry is much more recent in Great Britain than in the United States, and Englishmen interested in the subject turn to the work of Gilbreth, Link, Tead and many others for a study of the basic principles.

The bulk of the present book is concerned with a study of vocational fitness and industrial efficiency. The author has certain convictions regarding the value of tests in personnel work. Believing that impressions, testimonials, or school certificates are unsatisfactory methods of selection, he contends that a scientific measure of intelligence should be employed. He considers various forms of tests in detail, but the value of these tests is very problematical and it is still questionable whether for the average job the results obtained by them are worth the time and effort required.

For special work requiring certain definite mental qualities, of course, tests have proved their worth, and accuracy, reaction time to stimulus, quickness of thought and range of general knowledge can be correctly determined by various tests now in use.

A second field where psychologists have done work worthy of consideration is in the study of the factors which stimulate and which retard efficiency. Strength of motive decides the extent of activity, and some of the questions the author discusses are these: What motives other than the monetary wage affects production? Is there an instinct of workmanship in modern industry? Is it worth while to try and make the worker happy in his work? Can something of the zest of play be imparted to the toil of the factory? These are questions which the psychologist can help management to answer.

In speaking of fatigue the writer says:

> Nature's own rest is sleep. Unless a sufficiency of sound and restful sleep is obtained, more or less central fatigue will always be present. The efficiency of industrial work will therefore depend to a considerable extent on the conditions under which the worker obtains his nightly sleep.

He might have added that very much also depends upon whether or not the worker gets the amount of sleep he needs. With the attractions of the evening, with late hours at balls and lodges and at other places it is very evident that today a large proportion of the workers report to work in the morning more or less fatigued and able to do only a portion of the work which they might do if more completely rested by adequate sleep.

Another interesting observation of the author is this:

> Rhythm always has what may be justly described as an emotional value, and it is largely because of this emotional value that it plays the part in activity which it has been shown to play. Monotony which is a matter of the mental attitude rather than of the nature of the work, might be supposed to be at its maximum when regular rhythmical movement is maintained over a long period. Practically, however, the reverse happens. The emotional effect of rhythm has been utilized in work and in play from very early times. This emotional effect no psychologist has yet satisfactorily explained. He must rest content with the knowledge that such a principle exists, and that work can be facilitated and made pleasant by due regard to the phenomena in which it manifests itself.

The use of music in certain industrial plants has proved that production is thereby increased. The hands and the brain respond to rhythmic impulses.

In Great Britain an effort is now being made to correlate the science of mind with the various problems of industry and commerce, and for this purpose there was recently opened in London a national institute of industrial psychology. The author has a plan of his own for a central institute of this kind, and he believes that the council of such an institute could adequately represent all the different interests involved—those of the psychologist and the practical man, of the employer and the employee.

> This central institute would act as the heart and brain of a complex organization directed towards the practical applica-

tion in industry and commerce of the results of all research and of all knowledge bearing upon the welfare and efficiency of the human element.

Profit-sharing *658.384*

PROFIT-SHARING BY AMERICAN EMPLOYERS

A Report by the National Civic Federation
Publisher, E. P. Dutton and Company, New York

REVIEWED BY MARK M. JONES

"PROFIT-SHARING by American Employers" is a report of the National Civic Federation presenting the results of an inquiry conducted by mail in 1919. It is similar to a report on the same subject by the same organization in 1916, being not so much the result of a scientific survey, analysis, and study, as a collection of opinions, outlines of plans, and statements of experience synthesized by the staff of the Federation rather than by a committee. As such, however, it serves as an excellent mirror, reflecting the strength and weakness of profit-sharing.

The leading sections take up the following aspects of the subject:

Profit-sharing as viewed by George W. Perkins.
Definition of profit-sharing.
Specific plans and the opinion of an executive of the firm in question.
Stock ownership plans.
Exceptional plans.
Abandoned plans.
Press and magazine articles.
The attitude of Trade Union officials.
Some French and English plans.

No marked change in the methods of profit-sharing is indicated. The trend seems to be toward an increase in the number of stock purchase plans and toward combining the profit-sharing principle with some other management method in order to offset its weakness when standing alone.

The tenor of the opinions presented is more critical than formerly, the growth of a questioning attitude is apparent, the non-committal nature of many replies is conspicuous, and the absence of facts bearing on results and effects from which one might make his own deductions is regrettable. This should not be charged to the authors, however. The lack of standards for measuring management methods is one of the causes of this and is clearly reflected and emphasized by the volume. It is another piece of evidence pointing to the need for comprehensive management standards as gages for use in inspecting and appraising methods.

While one of the chapters deals with the definition of profit-sharing, the lack of general acceptance of clean-cut definitions is indicated by the replies quoted in the book. After years of experience in dividing the profits of industry, we evidently have not developed one method sufficiently acceptable to stand out preeminently as profit-sharing. The term is generally applied in a very loose way and to anything from a dividend on stock, a bonus based on profits, pensions, and insurance, to piecework rates. It seems to be about time that a more general agreement is arrived at as to what is and is not to be classified as profit-sharing.

An analysis of the contents of the volume showing the situation in 1920 is given in Table 1.

This table, however, does not cover the firms which failed to reply to the inquiries of the Federation and which amount to a score or more.

The profit-sharing movement does not seem to be making progress at present, and the material presented here does not convince one of the contrary. In comparison with the growth of industry, one must believe that it has actually lost ground.

The test of years points to the greatest usefulness of profit-sharing where the number of people concerned is small. It also seems to have strength where the net result of the work of individuals above and beyond volume of business is to be taken into account, such as in the case of salesmen; also for the managerial groups who have the greatest opportunity to influence profits in either large or small enterprises; and finally as a temporary measure to promote stock ownership. On the other hand, however, it discloses many points of weakness.

At a time of falling prices, depression, and slackening business, when profit-sharing is needed most as an incentive to improve results, the idea loses its appeal. The decline or total disappearance of profits soon becomes known to all the parties in the enterprise, and profit-sharing as an incentive thus fails at the most critical moment. Aside from this, the amount assigned to each participant is usually so small as to make little or no appeal to the average worker. The uncertainty of the reward, depending as it does entirely on profits made, also reduces the strength of its appeal, as employees prefer to have regular and dependable compensation—wages rather than bonuses.

TABLE 1. AN ANALYSIS OF THE TABLE OF CONTENTS OF "PROFIT-SHARING BY AMERICAN EMPLOYERS"

ITEM	ALL PLANS	PERCENTAGE OF PROFITS	SPECIAL DISTRIBUTION	PRODUCTION BONUS	STOCK OWNERSHIP	EXCEPTIONAL PLANS
Number of firms mentioned	337	46	142	11	58	25
Enthusiastic expressions on results or benefits	29	7	9	2	8	3
Favorable expressions on results or benefits	92	14	43	2	21	12
Non-committal on results or benefits	24	7	11	1	2	3
No expression on results or benefits	67	7	36	3	16	5
Benefits questionable	39	6	23	2	6	2
Opposing profit-sharing	9	..	9	..	..	..
Discontinuing plan	22	5	11	1	5	..
Profit-sharing plan abandoned	55	..	..	..	..	..

Whether a plan for sharing profits is true profit-sharing or not might be determined by examining the tax return of the enterprise. If the amount involved is actually paid from profits and not deducted as an operating expense, it might be considered an actual share of the profits. If, however, it is deducted as an operating expense, it would appear to be a "bonus" based on profits. While the contents of the present volume do not present the necessary information to check up this aspect of the case, independent inquiry indicates that in the final analysis, and with few exceptions, profit-sharing payments represent a bonus based on profits. Otherwise they fall within the classification of a philanthropic measure and represent a gift.

As a management method of providing an incentive for the worker, the final results of business operations as a whole are the basis for profit-sharing payments. That such schemes of payment have not been more widely adopted seems to be due to their general nature. From an industrial standpoint we have specialized so much that the average person has difficulty in comprehending a business as a whole or a general proposition. A bonus based on specific performance in a department or division is more favorably regarded. We have yet to raise the level of education to the point where the average person will add up the elementary problems of a business and determine the dominant problem. A payment based on the general result of the combined effort in a business is therefore not in such general use at this time.

The chapter entitled "The Attitude of Trade Unions" quotes a number of union leaders. The ideas presented, however, are more those of the leaders than of the rank and file of labor. No evidence of an expression by the membership of unions on the subject of profit-sharing is presented in this volume, nor has such an expression developed from other investigations with which the present writer has been in touch. In fact, Mr. Gompers is quoted in the book as saying: "This proposition has never been seriously considered by the organizations of labor."

One cannot read the book without benefit. It should appeal to the student of industrial problems as well as the technician who must formulate or apply sound business policies. It should acquire value from an historical standpoint also, as periodic surveys of this nature are the only means available for determining the trend of such movements.

Wage tables *331.2 : 510.81*

MULTIPLICANDUM CALCULATOR AND WAGE SCALE

Publisher, Arthur M. Duff, Boston, Mass.

REVIEWED BY A. H. CUBBERLY

Industrial Engineer, E. I. DuPont deNemours and Company

THIS book consists of a very conveniently arranged set of calculations, adapted for labor cost computations, time card extensions, etc. The tables may also be used for figuring surfaces, estimating materials and for extending invoices, freight rates, or stock books.

All the tables are of the same form, being different only in the basic figures and the amounts; and since their arrangement is not complicated, they are easy to use after a few minutes examination. The basic figures across the top of the tables and down the sides may be used for either the quantity or prices as the amount shown at the intersection of any two rates is the product of the basic figures above and at the sides of the result. A feature adding greatly to the convenience of the book is the fact that all figures pertaining to any two numbers are given in a single column and therefore are readily accessible. Moreover, the figures go much higher than those in any similar book the reviewer has yet seen.

The tables are made up for different wage rates or figures. There is a separate table for each amount, from ¼ to 100¾, progressing by ¼. After this there is a table for each amount from 101 to 152, inclusive, progressing by units. Each table shows the amount due in wages for any time spent, from 1 min. to 200 hr. by hours, ¼ of an hour, 1/3 of an hour, 1/6 of an hour and ⅛ of an hour and 1/10 of an hour. It also shows the amount earned at any of the different rates from $0.25 to $1.52, for any number of minutes from 1 to 59, inclusive.

All of the information for any one rate is shown in a separate table for that rate. For example, under the heading for each wage rate or base figure there are three columns. The first column shows the amounts in units and hundreds (correct to two places) at the given rate for any number of hours, from 1 to 100, inclusive; the second column shows the same for any amount from 101 to 200, inclusive; the third column shows the amount for any number of minutes from 1 to 59, inclusive, and the amount is shown in the same column for any fraction of an hour or unit, from 1/10 to 9/10, from ¼ to ¾, from 1/3 to 2/3, from 1/6 to 5/6 and from ⅛ to ⅞.

Any computations for hourly wages or piece rates are given at a glance. Piece rate earnings for any quantity at piece rates per 100 or 1000 units are easily found by moving the decimal point. The same is true for computing time expressed in hours and hundreds. Instructions and examples for reference are given.

Materials. Handling in industry *653.54*

MATERIAL HANDLING CYCLOPEDIA

Roy V. Wright, Editor-in-Chief

Publisher, Simmons-Boardman Publishing Company, New York

THIS volume is a companion book to the "Car Builders' Dictionary and Cyclopedia," the Locomotive Dictionary and Cyclopedia, the "Shipbuilding Cyclopedia," and the "Maintenance of Way Cyclopedia." It, therefore, constitutes the latest addition to the library of transportation literature of its publishers.

The purpose of its compilers has been to bring together in a single volume complete, practical, working information concerning the many types of material handling machines and devices used throughout the industry. It has been written both for the executive

industry. It has been written both for the executive interested in reducing the cost of handling material, and the operating man who seeks information as to types of equipment best suited for his needs.

The text matter is divided into nine sections: definitions, hoisting machinery, package handling conveyors, loose material conveyors, conveying machinery details, elevators, trackless transportation, industrial rail transportation, handling systems.

The definition section, in addition to serving as a dictionary of material handling terms, methods, and devices, provides an index for the other sections of the book. Following the definitions, each device receiving further treatment has references to the page in the text section or catalogue section where the additional information appears. This method of referencing connects the definition, the detailed description of the device, its method of operation, and illustrations.

The text matter comprising the eight sections following the index, is subdivided according to the general classification of machines. Each one of these sections is amply illustrated, the views showing typical applications as well as general characteristics and appearances of the equipment and devices shown.

A general subject index covers the entire contents of the book in a form to make the information readily available.

RELATIVE INDEX FOR NOVEMBER 1921

The following index is based upon the so-called "Brussels" classification. It is prepared especially for MANAGEMENT ENGINEERING by the United Engineering Societies Library, and is a part of the general plan used by them for classifying and indexing all engineering literature. A description of the system and the manner in which it is employed in MANAGEMENT ENGINEERING will be found in the July, 1921, issue, pages 49-52.

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Tell me who your friends are
and I will tell you who you are.

AT VARIOUS TIMES WE SERVED:

Brighton Mills
Celluloid Company
Cleveland Twist Drill Co.
Hudson & Manhattan R. R.
Lewiston Bleachery & Dye Works
Lewis Manufacturing Company
National Carbon Company
National Cable and Conduit Co.
New York, New Haven & Hartford R. R.
Old Colony Trust Company
Strathmore Paper Company
U. S. Emergency Fleet Corp.

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By Edward M. Woolley

Illustrated by W. C. Dexter

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4—Coordination of purchasing activities.

5—Production schedules based on study of markets, thus stabilizing production.

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The Influence of Weather on Coal Consumption

A Method of Using Outside Temperatures to Check Boiler Operation

By MALCOLM C. W. TOMLINSON*

Consulting Engineer

THE present condition of the power plant problem is due to many reasons, of which lack of technical engineering skill is probably the most important. Inadequacy of records used, indifference, absence of proper training on the part of many operating engineers and firemen, insufficiency of present compensation, and future reward for diligence, and misleading statements by salesmen who promise savings never realized, also exert a large influence on the economy, or lack of economy, which prevails.

What is this problem? Simply the securing of an efficiency equivalent to that obtained in production. Throughout the country most of the small factories and many large ones are using at least from 10 to 25 per cent more fuel than is necessary, are employing more help than is actually needed, are operating boilers at capacities between 25 and 75 per cent of their rating, and are only evaporating from 5 to 7 lb. of water to the pound of coal fired. In this last statement lies the essence of the matter, for efficiency in boiler operation depends on the number of pounds of water evaporated per pound of coal fired and good practice will give from 8 to 10 lb. and without any elaborate outlays for equipment.

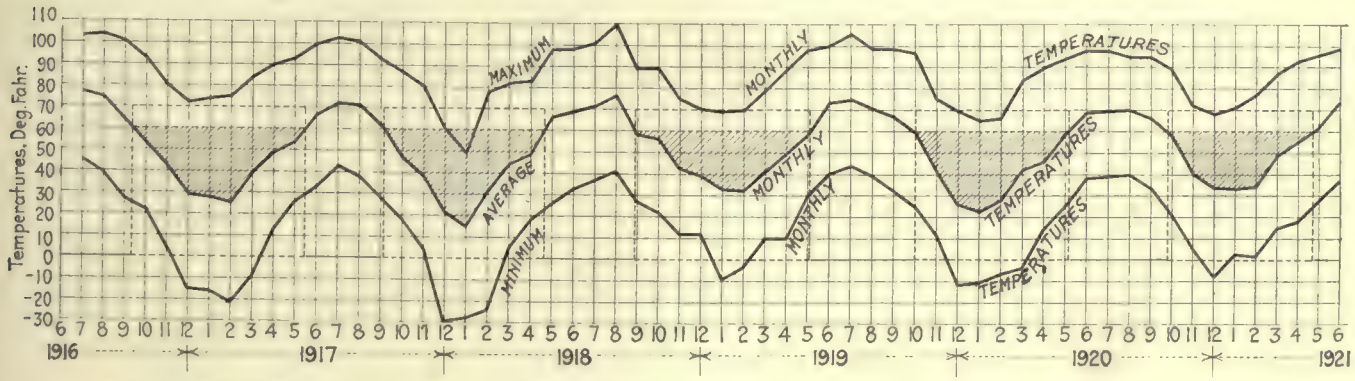

FIG. 1 CURVES SHOWING THE RANGE OF TEMPERATURE IN THE STATE OF OHIO FROM JULY, 1916, TO JULY, 1921

In this figure the maximum or theoretical heating requirement for any heating season is represented by the space enclosed in the rectangle bounded by the 70 deg. and the zero lines, and by the vertical lines which intercept the points where the temperature curve crosses the 60 deg. line. The average or actual heating requirements for this period will then be the shaded area between the 60 deg. line and the temperature curve, because this area represents the heat units required to give an average inside temperature of 60 deg. fahr. during such heating season.

What is the practice of the average central stations? Boilers are driven at from 150 to 300 per cent of their rating and are fired to evaporate from 8 to 12 lb. of water to the pound of coal. Why this difference? Simply because these corporations are dependent almost entirely on their power plants for profits and they have learned by long experience the art of economical operation.

Factory management cannot hope to secure equal economy without technical aid but, by the use of simple records, they can at least obtain what they do not have

* Mr. Tomlinson learned the machinist trade and then spent one and a half years testing turbines and dynamos with the Westinghouse interests. Nine years after leaving high school he entered the Pennsylvania State College. His later experience includes maintenance work with the Baldwin Locomotive Works and the B. F. Goodrich Company; investigations and tests on the generation and use of steam, electric power, air, and water with the National Tube Company; assistant mechanical engineer with Robert W. Hunt and Company, Consulting Engineers; assistant engineer with the Underwriters' Laboratories, Inc.; and mechanical engineer for the McGraw Tire and Rubber Company. He established his present consulting practice early in 1920.

at present—a careful check on boiler operations. This check will make possible better economy than is now obtained, will educate management in the operation of power plant equipment, and will ultimately result in a vast improvement in all around efficiency.

The object of this article is to call attention to the influence weather has on fuel consumption and to present a method by which management can check boiler operations by means of data on outside temperatures.

The U. S. Department of Agriculture operates a Weather Bureau with divisional headquarters in each state. A large number of observation stations have been established in all sections of the various states, and the records thus obtained often cover many years. The information secured consists mainly of the temperature in degrees fahrenheit, the precipitation in inches, the barometric pressure in inches, the relative humidity in per cent, the percentage of sunshine, and the direction of the wind, and its velocity in miles per hour. Much of this information is valuable in the construction and operation of power plants. The percentage of sunshine should be considered in lighting layouts and in the selection of materials and colors for walls, ceilings, and equipment. Prevailing winds control the bracing required for buildings and chimneys and play an important part in draft. Precipitation determines roofing requirements and plays a large part in water supply. Barometric pressure influences the operating economy of condensing engines. Last, but not least, is the average outside temperature. The part it plays and the uses to which it can be put will be considered in detail.

In order to furnish a clear concept of outside temperatures and their use, analysis of the monthly temperatures for the state of Ohio through the past 25 years is presented. Since the use of coal is at a maximum during winter months the year in this analysis will be taken as that period between June 30, and July 1, of the year following. Maximum, average, and minimum monthly temperatures are plotted for each year and Fig. 1, which covers the years 1916-1921, inclusive, will serve as an illustration, while Figs. 2 and 3 furnish composite plots for the 1900-1910 and the 1910-1920 periods.

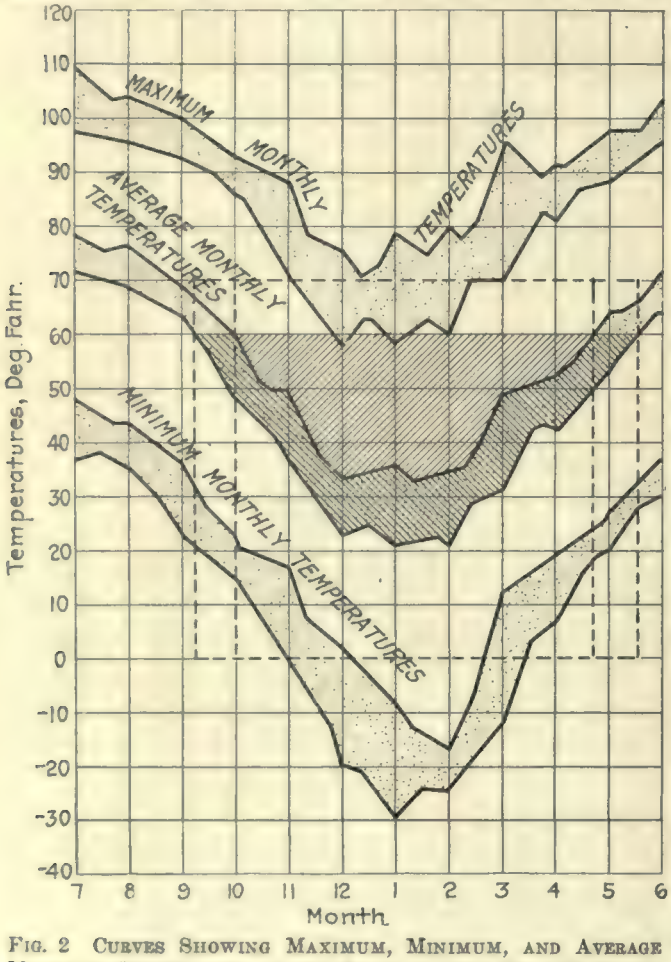

FIG. 2 CURVES SHOWING MAXIMUM, MINIMUM, AND AVERAGE MONTHLY TEMPERATURE IN THE STATE OF OHIO FOR THE PERIOD FROM JULY, 1900 TO JULY, 1910

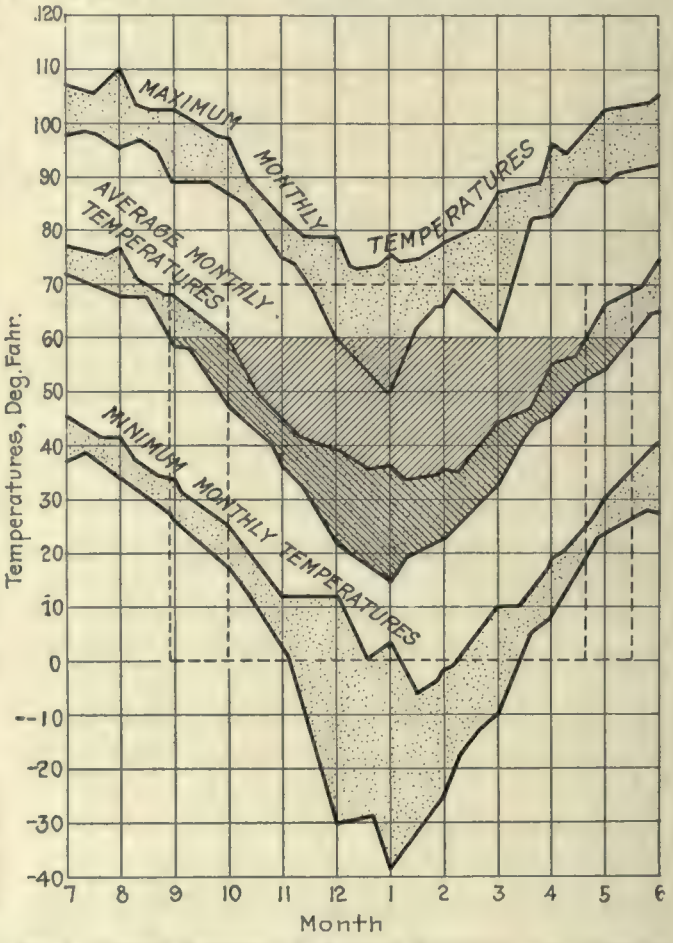

FIG. 3 CURVES SHOWING MAXIMUM, MINIMUM, AND AVERAGE MONTHLY TEMPERATURE IN THE STATE OF OHIO FOR THE PERIOD FROM JULY, 1910 TO JULY, 1920

Heating requirements are usually figured to meet the heat losses of a given structure with an outside temperature of zero and an inside temperature of 70 deg. fahr. although many engineers use a lower outside temperature limit for northern localities. In this article zero will be used and the reader is reminded that lower outside limits would change the heating ratios given in Table 1.

The maximum or theoretical heating requirement for any heating season can be represented graphically by

the space enclosed in a rectangle bounded by the 70 deg. and the zero lines, and by the vertical lines which intercept the points where the temperature curve crosses the 60 deg. line. The average or actual heating requirements for this period will then be the shaded area between the 60 deg. line and the temperature curve,

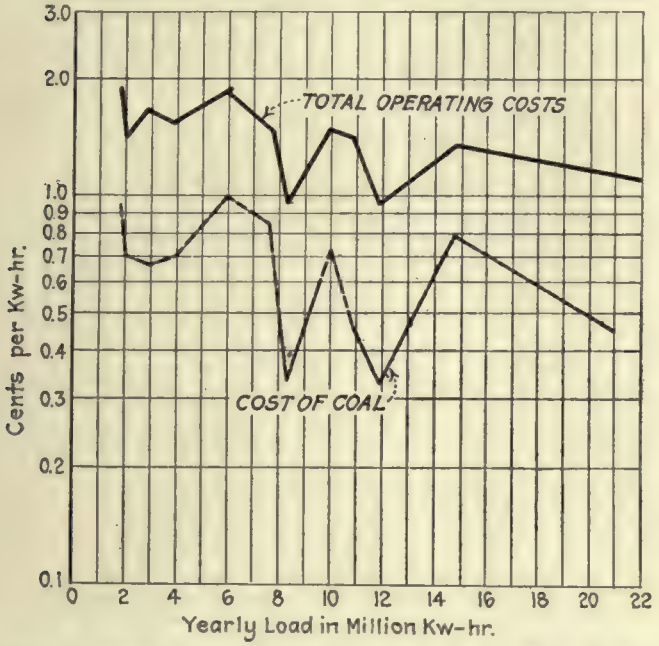

FIG. 4 CURVES SHOWING THE INFLUENCE OF THE COST OF COAL ON THE TOTAL OPERATING COST OF A LARGE POWER PLANT

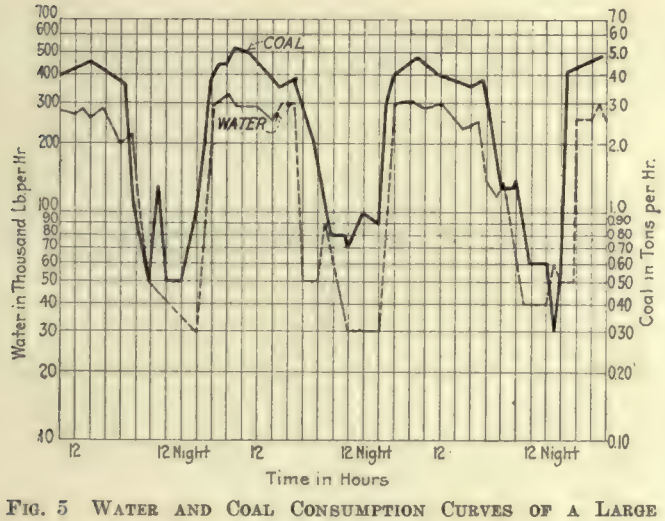

FIG. 5 WATER AND COAL CONSUMPTION CURVES OF A LARGE HEATING STATION

because this area represents the heat units required to give an average inside temperature of 60 deg. fahr. during such heating season. Here we have a means by which coal needs can be calculated with a reasonable degree of accuracy and through which boiler operations can be checked. For those who wish the best results the temperatures for the particular locality concerned should be used.

Measurement by planimeter of the maximum and average areas for the state of Ohio over a period of 25 years, or from 1896-1897 to 1920-1921, inclusive, has given the ratios between theoretical and actual heating requirements which are shown in Table I.

With this information at hand a number of interesting facts are uncovered. The first is the remarkable uniformity of the yearly heating requirements. Next we find that, notwithstanding blizzard conditions, the heating requirements for 1917-1918 were very close to the normal or average for the 25-year period. While comparisons between the maximum, average, and minimum monthly temperatures can be obtained only with the aid of ratio or semilog paper it is evident that they rise and fall at approximately the same rates. Another remarkable point is the closeness with which the length of each heating season clings to the average. No doubt analysis of weather bureau data for those years preceding the 25-year period analyzed would help disprove the idea that winters are growing milder and would show that the uniformity noted was practically a constant.

TYPICAL POWER PLANT CURVES

A few typical power plant curves will be useful in bringing out certain facts relating to temperatures and the use of coal. In the first, Fig. 4, the influence of the cost of coal on the total operating expense of a large power plant is shown. Fig. 5 gives the water and coal consumption for a large heating plant and brings out the close relation between these two items when used for heating alone. The influence of outside temperatures on water consumption in the power plant of Armour Institute is presented in Fig. 6, while the influence of outside temperatures on coal consumption in the same plant is given in Fig. 7. The information presented in Figs. 4 and 5 was collected by Professor Josse of Char-

TABLE 1. RATIOS BETWEEN THEORETICAL AND ACTUAL HEATING REQUIREMENTS

YEAR	LENGTH OF SEASON MONTHS	YEARLY RATIO	FIVE-YEAR RATIO	TEN-YEAR RATIO
1896-97	7.1	28.2		
1897-98	7.6	26.6		
1898-99	7.4	27.8		
1899-1900	7.1	29.2		
1900-01	7.4	30.3	28.4	
1901-02	7.7	31.1		
1902-03	7.5	27.5		
1903-04	7.3	30.4		
1904-05	7.6	32.6		
1905-06	7.5	28.5	30.0	29.2
1906-07	8.0	27.1		
1907-08	7.5	26.3		
1908-09	7.6	26.2		
1909-10	8.4	24.0		
1910-11	7.0	30.0	26.7	
1911-12	7.3	32.1		
1912-13	7.5	26.1		
1913-14	7.4	27.3		
1914-15	7.7	26.3		
1915-16	7.3	27.7	27.9	27.3
1916-17	8.1	27.5		
1917-18	7.5	32.6		
1918-19	8.4	22.4		
1919-20	7.3	31.7		
1920-21	7.0	23.9	27.6	
Average for 25 years	7.5	28.1		

lottenburg, who made a survey of all the large power plants of Germany, while the data contained in the four figures were plotted on ratio paper in order to bring out the rates or true comparative values of each set of curves.

As the information shown in Fig. 7 has been obtained from a carefully operated power plant it can be used

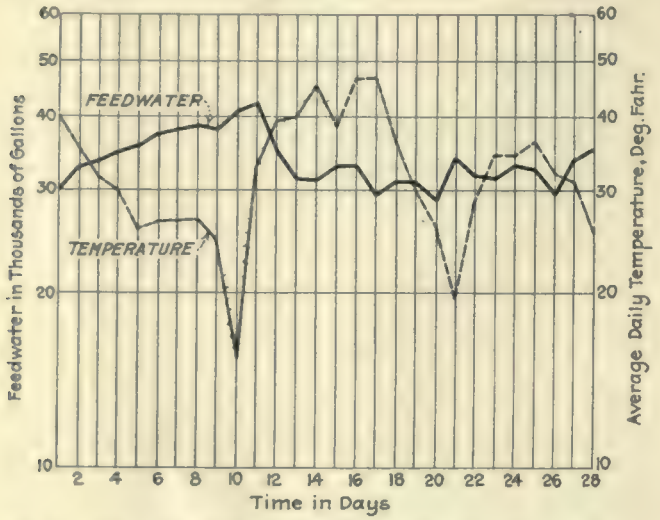

FIG. 6 THE INFLUENCE OF OUTSIDE TEMPERATURE ON FEED WATER CONSUMPTION

These load curves were plotted from tests made in February, 1911, on the power plant of the Armour Institute of Technology.

with safety or without the fear that serious wastage would distort the results. Accordingly these data have been arranged in Figs. 8 and 9 so that the first six months of 1911 follow the last half of the same year. The exact location of the coal curve in Fig. 8 with reference to the temperature curve was determined by cutting out these curves, laying one on top of the other, and locating the coal-in-tons index number which corresponded with the temperature index 60. It was found that the coal curve had the same width at 320 as the temperature curve had at 60. From Fig. 9 it was found

TABLE 2. COAL CONSUMPTION IN TONS FOR A CAREFULLY OPERATED SMALL POWER PLANT

MONTH	TOTAL	HEATING	POWER
uly	60	0	60
August	50	0	50
September	140	0	140
October	450	70	380
November	750	250	500
December	760	250	510
January	940	310	630
February	850	280	570
March	750	265	485
April	620	135	485
May	240	0	240
June	70	0	70

that the heating season was 7.2 months long and that the heating ratio was 30.2. As the coal consumption for heating purposes alone is represented by the shaded area in Fig. 9 the monthly usage of coal for heating can

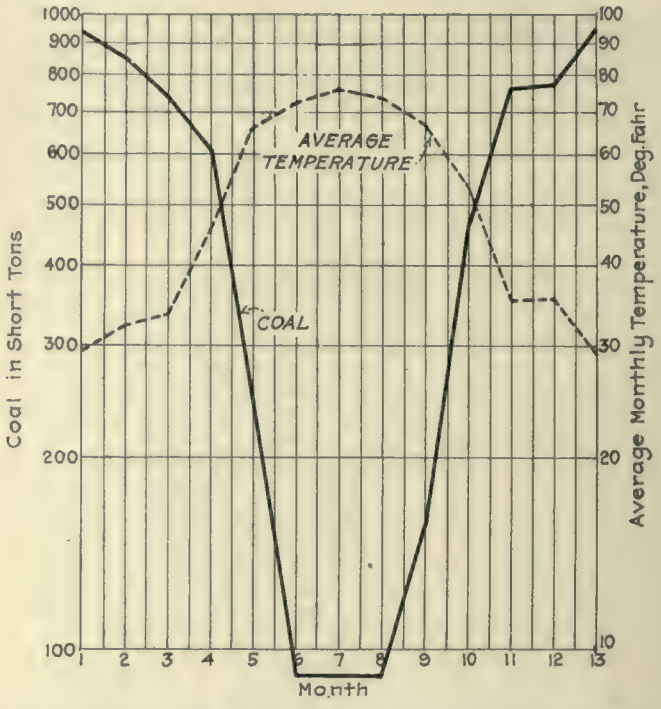

FIG. 7 THE INFLUENCE OF OUTSIDE TEMPERATURES ON COAL CONSUMPTION

The above two curves of temperature and coal consumption were plotted from data secured from tests made in February, 1911, on the power plants of the Armour Institute of Technology. They should be considered in connection with the data presented in Figs. 6, 8, 9, and 10 and Table 2.

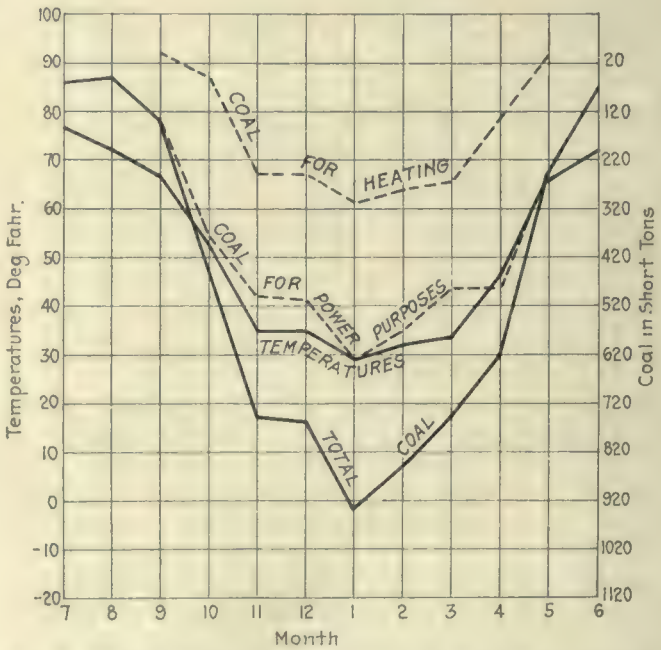

FIG. 8 CURVES SHOWING VARIATIONS IN COAL CONSUMPTION WITH AVERAGE TEMPERATURE FOR THE PERIOD JANUARY, 1911 TO JANUARY, 1912

This set of coal consumption curves is based upon the information presented in Figs. 6 and 7. The data has been arranged so that the first 6 months of the year follow the last half of the same year, and from the curves thus obtained, and data presented by the curves of Figs. 6, 7, and 8 the values of coal consumption given in Table 2 were secured.

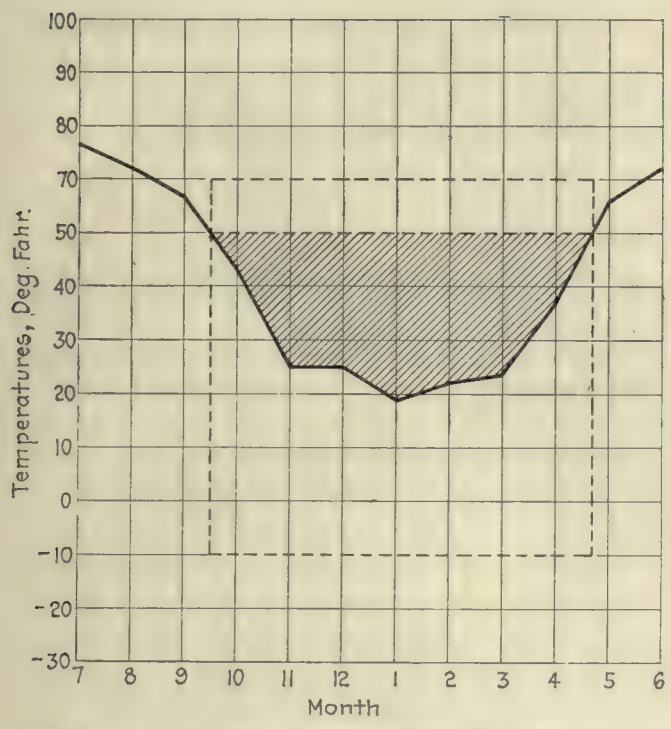

FIG. 9 CURVES SHOWING AVERAGE MONTHLY TEMPERATURE IN THE CITY OF CHICAGO FOR THE PERIOD JANUARY, 1911 TO JANUARY, 1912

This curve must also be considered in connection with the data presented in Figs. 6 and 7, and taken in conjunction with the data of Fig. 8, it gives the information presented in Table 2.

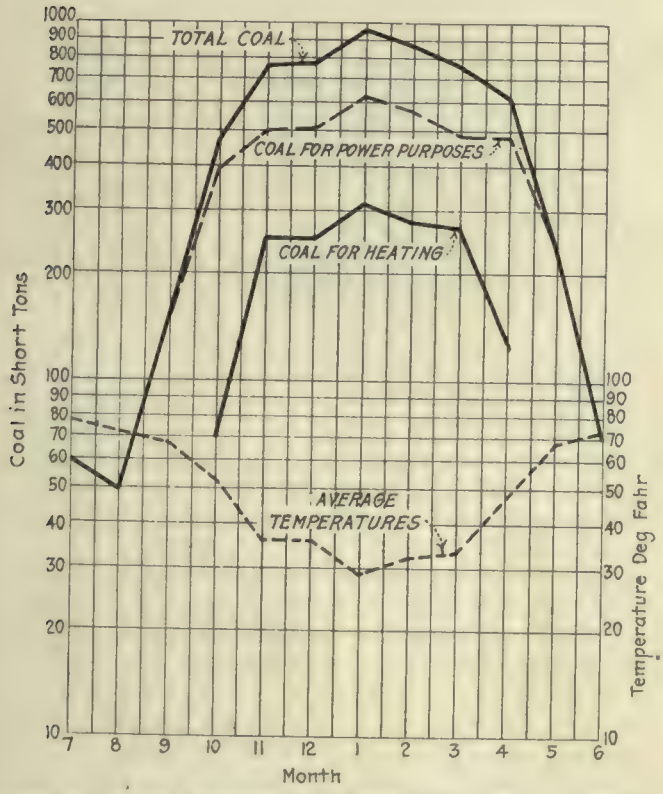

FIG. 10 CURVES SHOWING COAL DISTRIBUTION IN A CAREFULLY OPERATED SMALL POWER PLANT

The tonnage figures of coal consumption presented by the three curves of this ratio chart are plotted from the data presented in Table 2.

be taken as equal to the difference in tons between the monthly points on the temperature curve read off from the coal-in-tons index and the 320-ton point. Then the difference between the total monthly tonnage and the tonnage estimated for heating gives the tonnage for power purposes alone. The data thus obtained are given in Table 2

These tonnage figures are plotted on ratio paper in Fig. 10, bringing out clearly the value of this method as

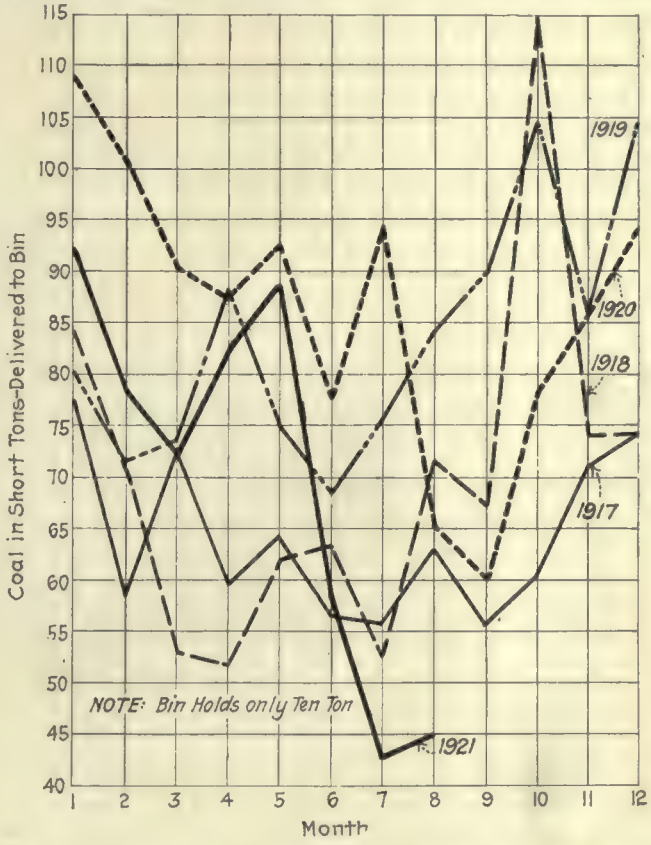

FIG. 11 YEARLY COAL CONSUMPTION CURVES FOR POWER AND HEATING REQUIREMENTS OF A TANNERY

This set of curves shows how the quantity of coal purchased varied due to a lack of control. The yearly coal consumption in tons is given in Table 3.

a check. Managers who have no engineering departments, and accountants will find it a handy method for estimating the proper proportions of coal which should be assigned to heating and to power.

Not only can the method outlined be used to segregate the power and heating tonnage but it is very evident that it can also be used to determine when waste exists because of improper firing or other causes. Wastage can be found, and even roughly determined, from the fact that the coal curves would show erratic con-

TABLE 3. COAL CONSUMPTION IN TONS DELIVERED

	1917	1918	1919	1920	1921
Yearly quantities....	770¾	840	998	1036¾	
Quantities for the first 8 months of each year.	509	510	618½	718	559¼

sumption when laid out properly and that the slopes of the temperature and coal curves would have very little relation.

PRACTICAL APPLICATION OF THE METHOD

For an example of the practical use to which this method can be put in power plants which have no scientific control the coal usage of a tannery has been selected. The recorded data consisted of one item—the coal purchased. In all cases except that of October, 1918, these data also represent the coal delivered. As the coal bin could only hold 10 tons the actual consumption must have been very close to the quantities purchased. The coal records are graphically shown for the period January, 1917, to September, 1921, in Fig. 11. A gradual increase in monthly usage will be noted until January, 1921, when operations were curtailed. The annual quantities and those for the first 8 months of each year are given in Table 3.

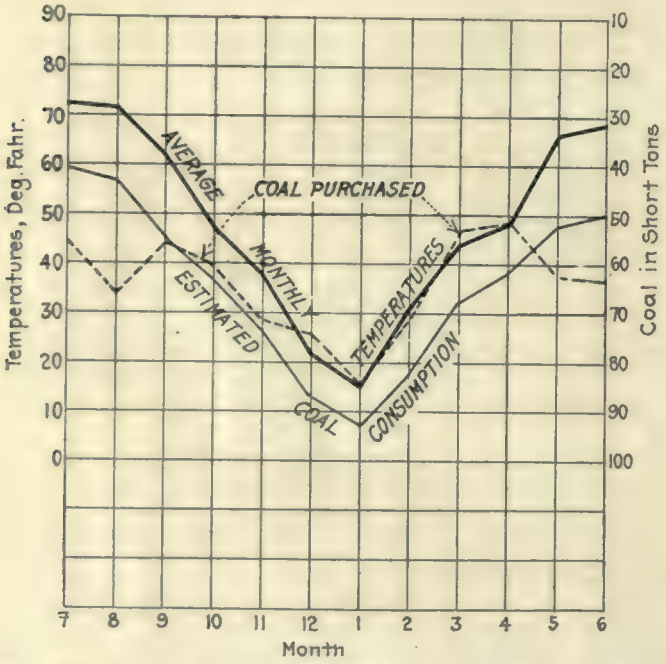

FIG. 12 CURVES SHOWING RELATIONSHIP BETWEEN AVERAGE MONTHLY TEMPERATURE, ESTIMATED COAL CONSUMED, AND COAL PURCHASED FOR THE PERIOD JULY, 1917, TO JULY, 1918

These curves show that for the period named the temperature index stood at 60, with a corresponding coal index of 56. Compare this data, which was secured under the old conditions with that shown by Fig. 13

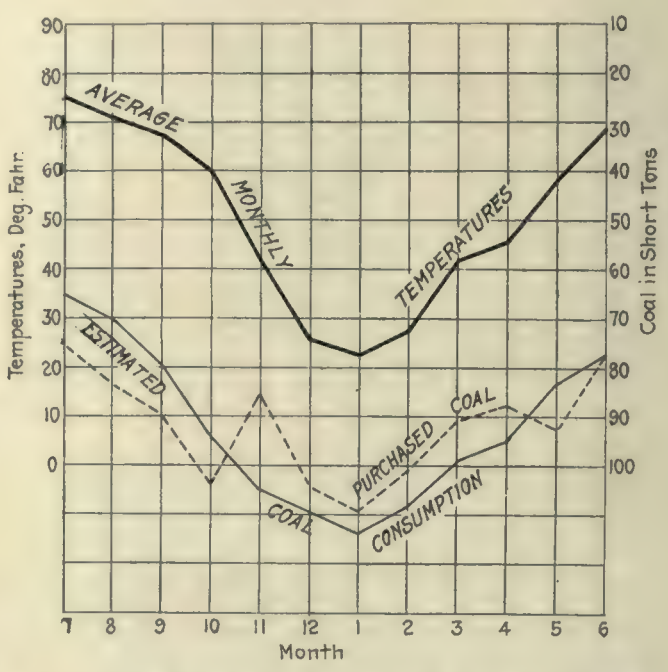

FIG. 13 CURVES SHOWING RELATIONSHIP BETWEEN AVERAGE MONTHLY TEMPERATURE, ESTIMATED COAL CONSUMPTION, AND COAL PURCHASED FOR THE PERIOD JULY, 1919 TO JULY, 1920

These curves show the condition that existed after proper control had been installed. The temperature index still stands at 60 but the coal index is now 85, a saving of 29 tons over the 1917-1918 period shown in Fig. 12.

Analysis of coal usage by means of temperature data for the periods 1917-1918 and 1919-1920 was possible after plotting the data in Figs. 12 and 13. The "coal purchased" curves in both periods were straightened out by equal subtractions and additions to approximate the actual consumption based on the knowledge that the consumption curves would take the general contours of the temperature curves. The temperature index 60 was then found to correspond with the coal index 56 for the 1917-1918 period and with the coal index 85 in the remaining period. With constant production from 1917 to 1921 this at once shows a monthly wastage around 29 tons based on the 1917-1918 performance. The actual wastage due to all causes might be higher than this quantity because there is no proof that the consumption during 1917-1918 did not include bad leaks.

ELIMINATING THE CAUSES OF WASTE

The causes for the wastage noted were determined by a steam survey which was made in June, 1921. Tests made on three steam engines and one steam-driven air compressor showed the need of adjustment and repairs for this equipment. After the valves and eccentrics were set properly in June the coal usage dropped to points much lower than those reached in the previous four-and-a-half years. Repairs on the slide valve of the air compressor, completed in September, cut out a large leak due to the escape of live steam through a badly worn D-valve into the exhaust without performing any work.

While other leaks were uncovered by the survey, which were due to improper installation and equipment, it is certain that the wastage located in the operation of the engines and compressor was the greatest found. With the correction of these leaks the coal usage will more nearly follow the temperature curve.

The results obtained in the use of this method for the control of coal consumption seem to prove not only the value of the method, but also its general application, for such coal wastage is revealed, the opportunity is offered to determine causes, and after eliminating steam leakage a permanent basis of control is reached.

An Organized Transportation Department

Operated on Schedule Under a Department Manager

By JOHN A. MacCREA*

Production Manager, The Prest-O-Lite Company, Inc.

IN the leading article in the August number of MANAGEMENT ENGINEERING, R. M. Gates makes a plea for the organization of the internal transportation of material in manufacturing plants and recommends the setting up of a special department for this purpose. He indicates the kind of man who should be in charge of this department and outlines the knowledge which such a man should possess. Mr. Gates says in part:

A true production manager is greatly needed. He should be responsible for the movement of material from the time of its receipt until it is shipped. He should be a master of the art of handling material, familiar with all types of mechanical appliances, their relation one to the other as applied to industry. He should also realize that the proper application of these machines is the basis of a greater and more profitable production.

In the course of his remarks, Mr. Gates also puts the following question: "Where, however, do we find a specialist or a department whose whole concern is the moving of material?" The present article is a reply to that question and an attempt to describe briefly the organization and principal features of operation of such a department. The department in question has been established to take care of the internal transportation of a manufacturing plant, handling a wide variety of raw material from the moment of unloading upon its arrival and its passing through the successive stages of manufacture until it is delivered to the storeskeeper as finished product.

This transportation department was planned and established to meet a necessity. Failure to move promptly material and work-in-process leads to friction between departments, handicaps production, and tends to the undue increase of overhead charges. Without definite responsibility for the forwarding of material, blame cannot be placed upon anyone in particular, and no one can be held responsible.

The change from such a situation to one where there is a special department provided with proper equipment and having a definite organization and a clear responsibility does not, as some might suppose, entail an upheaval or general rearrangement of the plant layout, since the new department need not be installed completely at any one time. A beginning can be made without disturbing existing conditions, and gradually, as the organization expands and more work is undertaken, new units can be added to the organization until the plan is extended to all departments, and includes all of the moving and handling of material that needs to be done.

FIG. 1 A PLATFORM TRUCK USED TO UNLOAD BOX CARS

In explaining to department heads a plan of this kind the best approach is to make clear at the outset that its installation and successful operation will actually relieve them of a great deal of unnecessary work and release for productive labor a great percentage of now unproductive labor. Instead of a large force of men going about with hand-trucks more or less aimlessly, some of them with fully loaded trucks but most of them with only half a load, under the new system a fewer number of men are required because they work continuously and effectively. Furthermore under the new plan the workman does not need to leave his machine to get new material or take away his own finished work, and the foreman can concentrate on his problem of manufacturing and leave all of the trucking into and

* Mr. MacCrea has had an experience of 20 years in industry, principally as storeskeeper. Up to 12 years ago he was storeskeeper for several firms in railroading, lumbering, contracting, and steel furniture building. He took up work under the general direction of H. L. Gantt about 12 years ago. Previous to accepting his present position he was general storeskeeper for the Remington Typewriter Company for 10 years, and has been with the Prest-O-Lite Company for the past two years.

out of his department to an organization responsible for it, and perfectly able to care for it.

The transportation department should have its own separate organization, developed with a view to a definite object. Its work is to move all material, parts, work-in-process, and finished product from any place in the plant to any other place, in the shortest possible time and at the lowest possible cost. To operate successfully, such a department should be placed under one man who should be held responsible for all internal transportation, and for the selection, inspection, and maintenance of the equipment. Here, of all places, there can be no divided authority, for divided authority here will become a source of endless trouble. On the other hand, if on the establishment of the department a capable man is put in full charge, the department will become an invaluable addition to the facilities for economic production.

FIG. 2 AN ELECTRIC TRUCK AT WORK IN THE SHOP HAULING STEEL PUNCHINGS

To derive the greatest benefit, the co-operation of all the other departments in the plant with the transportation department must be secured. In particular between the storeskeeper and the transportation men, being as they are the servants of the entire factory, there must be the closest kind of co-operation and general assistance, so that they may render the maximum of service and keep a continuous, even flow of all material and parts through all departments, thus insuring that no department will be underserved and none overserved. Inasmuch as the transportation department is one of the production facilities of the plant it is logical to place it under the control of the production manager. In practice this has been found a satisfactory arrangement, inasmuch as the production manager can direct the work through the general storeskeeper who has direct responsibility for all the stores. These two executives possess knowledge as to when and where material is wanted, and are in a position to direct its handling.

In a certain plant the following arrangement has been made: Under the general storeskeeper is a transportation foreman who is primarily responsible for the transportation service, including the prompt unloading and safe storage of all raw material and parts received at the plant; the collection and disposal of all refuse; the maintenance of docks and yards and the keeping them clean; and the up-keep of trucks and tools used by the department together with their safe operation. In addition, the timekeeper of the transportation department is required to act as a car clerk. Chauffers, truck-drivers, and laborers complete the personnel of the transportation department.

To secure economic operation a daily schedule for trucking is arranged between the departments, the foremen, and the transportation head. This schedule is laid out in an office having a clerk who is always within reach of the telephone. Telephone requests must receive prompt attention, and the transportation department must give the same service whether Bill Brown wants a barrel of sawdust or Sam Jones a ton of lead. Naturally, with such a schedule in operation, rush

FIG. 3 A PLATFORM TRUCK USED FOR MOVING MATERIAL FROM SHOP TO SHOP

orders are unwelcome. The transportation men argue, justly, that departments should anticipate their needs at least an hour in advance so that their material may be handled in regular schedule instead of sending in rush calls which break up routine and add to expense.

The wide range of commodities handled is difficult to describe. One load may be lumber; another, scrap-iron; another, compound; and, perhaps, a fourth, pig-lead. The equipment consists of hand-barrel trucks, electric lift trucks, platform trucks, and tiering machines, such as shown in Figs. 1, 2, and 3. Two docks each one-quarter of a mile long (Fig. 4) are also provided for use in loading and unloading. In addition to the movable equipment, the use of portable roller conveyors has simplified unloading of cars and effected a marked reduction in cost. Today pig-lead is being unloaded and properly stacked for 10 cents per ton, coke, delivered to department for 25 cents per ton, and oxides unloaded and stacked for 20 cents per ton. When 383 tons a month are handled, the average amount of material moving per day, per man, is about 14 tons.

FIG. 4 AN ELECTRIC TRUCK WITH TRAILERS EMPLOYED IN MOVING LIGHT PARTS

With regard to the type of man preferred for chauffers, truck-drivers, and laborers—that is, for "move men"—young and preferably married men are selected, who have sufficient intelligence and willingness to handle all material carefully and operate the trucks with caution and judgment.

The plan of the schedule brings a truck several times a day to each department. The driver and his helper are instructed exactly what to do. All aisles are kept clear, and every facility is afforded the truck by department foremen to assist in making good on its schedule. Once every hour the drivers of the scheduled trucks call at the schedule office so that they may be assigned any "pick-ups" or other job along their routes.

Along the docks the unloading gang is assisted by the remainder of the trucks in unloading the cars received for the storeskeeper, to whom their contents are consigned. To supplement the electric trucks, trailers of several kinds are used. Some have slat bodies, adapted for carrying boxes and light bundles (Fig. 4), so that a string of them can be hauled up an incline without displacing the load.

Without attempting to state the saving in dollars and cents, it is evident the production wage is affected by the speed with which cars are emptied and their contents conveyed to the storeskeeper when this work is done under plant control. The saving in man-power is evident from the comparatively small number of men required for the work. The laborious hand-truck is eliminated. A lift truck running under a skid lifts a 2-ton load and carries it away in 1/10 of the time needed to transport it by hand-truck. In this way the human dread of the "bull gang" is gone, and a conservative estimate of the saving effected by this organized electric-equipment transportation system over the "bull gang" is 50 per cent.

A question that will at once enter the mind of many factory executives is the effect of such a department upon accidents within the shop. It is the general experience that falling objects form one of the prolific causes of accidents in industry, and objects are more apt to fall during transportation than at any other time.

The experience of the department described in this article is that accidents are a rarity where the equipment is well maintained. It is essential, however, that each truck and tool be examined frequently and that the most trifling defects be immediately remedied. Moreover, it has been found that a few warning signs posted at the corners of buildings and the selection and instruction of careful operatives help to reduce the risk of accidents to a minimum.

Personnel executives *658.373*

Training the Industrial Relations Executive

By EDWARD S. COWDRICK

Asst. to the Vice-President, The Colorado Fuel and Iron Co.

THE business collapse of 1920 found American industry engaged in unexampled efforts to better the relationship between workmen and management. Employee representation, profit-sharing, mutual service, medical attendance and accident prevention were being conducted on an unprecedented scale. Many corporations have continued these activities through the months of depression, and some have even broadened their scope, in the belief that advanced methods of personnel administration are desirable no less in a period of adversity than in an era of prosperity. Other employers have discontinued or materially curtailed their

efforts, having reached the conclusion, by one course of reasoning or another, that expenditure for maintaining harmonious industrial relations was unjustified in a time of vanishing profits.

However reactionary in some instances may have been the temporary results of the business stagnation of 1920 and 1921, few who give serious thought to the subject will deny that personnel management has become a permanent factor in industry—a factor the importance of which will increase from year to year. No less is it evident that industrial relations activities in the future will be conducted along lines more scientific than in the past; that there will be more justice and less sentiment, and that the men who direct these functions will be called upon to show solid results to the joint benefit of employer and employee.

At the opening of this new stage in the development of personnel administration it is, therefore, not improper to pause and inquire: What is an industrial relations executive, and, how is he to be trained?

WHAT IS AN INDUSTRIAL RELATIONS EXECUTIVE?

The work of the personnel manager may be said to be that branch of industrial engineering which concerns itself with all the human relationships within industry. Among its requirements are a few fundamental qualifications, some inherent, others acquired.

Among the natural qualifications of the industrial relations engineer first rank should perhaps be given to love of humanity. The man who does not love his fellow men, who does not sympathize with them in their struggles and their aspirations, has no place in the field of industrial relations, however impressive may be his attainments or however profound his knowledge.

Of almost equal importance is understanding of human nature. Industrial relations depend upon the actions of human beings under varied sets of conditions. It is essential that the leader in these activities be able to judge with accuracy what will be these reactions.

But a man may love humanity and understand human nature and still be unfitted for the profession unless he combines with these attributes a sense of justice so nearly unerring that it may be said to be instinctive. Justice is the cornerstone of all right relationships between employer and employee. The man who moulds these relationships should be one whose bent toward justice is like the inclination of the compass needle toward the north—instant and unswerving. He should have the ability and the courage to follow the path of fairness through the thickets of prejudice and self-interest with which it is often obscured.

The human engineer also has need of a personality and a character which will inspire confidence on the part both of the management and of the employees. The most constructive ideas are well-nigh useless without the ability to "put them over."

The industrial relations executive should have faith. He should have confidence in the ultimate victory of justice and fair play. He should have a resilient optimism that inspires him to persevere in spite of the numerous discouragements and reverses with which his path is certain to be beset.

Assuming the possession of these fundamental qualifications, what is the training through which the engineer of human relationships should pass?

Undoubtedly as broad a knowledge as possible of industry in general, and of the business of his own organization in particular, is desirable. The personnel man needs to be unceasingly a student—a student of all the elements entering into the endlessly complicated thing we call business.

This knowledge of the world's affairs should be coordinated with a wide experience in dealing with men. This experience may have been acquired in the workshop, in the office, or in the pulpit. It is the thing itself, not the method of its acquirement, that counts.

The writer believes that the schools—particularly the colleges and universities—can perform a function of enormous benefit to society by offering courses of study bearing directly upon human relationships in industry. These courses are of value not only to the future industrial relations engineer but also to the young man preparing himself for any position of responsibility in the business world.

COLLEGE COURSES IN INDUSTRIAL RELATIONS

To some extent this service already has been begun. Notably at the University of Wisconsin, under the direction of Prof. John R. Commons, and at Harvard, courses in industrial relations have been conducted successfully. Other institutions, including some schools of engineering, have done excellent work along the same lines. Further extension of this work, and more recognition of its importance, would add greatly to the value of the service rendered by the colleges.

It is not among the purposes of this paper to outline in detail the subjects desirable to be included in a college course in industrial relations. A thorough grounding in economics—theoretical and applied—would seem essential, whether the course is given in connection with a school of engineering or an academic institution.

Another subject of basic importance is the sadly neglected study of industrial history. The student or the business man who possesses a historical background for his industrial thought is much more likely to think constructively and act sanely than the one who lacks it.

Other subjects which properly might be included are social problems, business administration, and principles of labor legislation. Branches more directly connected with personnel management, and which may be classed as semitechnical, include labor management, employment methods (including job analysis and mental tests), safety devices and accident prevention, industrial sanitation, housing, and industrial education.

Co-operation between business and the colleges in building up a more adequate and more widely extended education along lines of human relationships in industry will go far toward correcting the mass of misinformation now prevalent, and at the same time will help to raise the business of human engineering to the truly professional plane upon which it rightly belongs.

Pulling Together Through Representation

Right Understanding Comes From the Joint Conference of Employer and Employee

By JOHN T. BRODERICK*

Industrial Analyst and Author

WHILE riding from New York to Albany in the smoking-room of a parlor car one afternoon recently, I listened to a dialogue in the course of which things lying wholly within the pale of my experience acquired a meaning which they had never had for me before. The subject dealt with was the so-called employee representation plan, under which the operation of manufacturing plants through extended co-operative effort is now being tried by corporations in different parts of the country.

The talk was started and its direction from time to time influenced by a traveling salesman with a philosophic turn of mind and a thirst for knowledge whose identity otherwise is of no special concern to the reader. The chief participant was a prosperous looking man of middle age who at first described himself as a manufacturer but announced subsequently that he was the president of a well-known corporation operating a group of plants in the Middle West employing some 30,000 people.

My reproduction of the dialogue is made with the knowledge of the two men described and an explicit understanding with the manufacturer that his name would not be mentioned.

An Important Fact Overlooked

The salesman thrust aside a newspaper which he had been reading and opened the dialogue thus: "Industrial leaders all over the country seem to be viewing the employee representation plan with favor. An article that I have just been reading indicates that much, but it fails to give a clear enough description of the plan, so far as its groundwork and purpose go, to enable a layman to form any opinion of its merits. One must be a close student of economics nowadays in order to understand what is happening in industry."

"The feature of novelty in the plan that you speak of," responded the manufacturer, "and the one that is causing those who seek industrial peace to turn toward it with hope, such as they have not had for years, is the recognition it gives to an important elemental fact which has been overlooked or obscured by controversy."

"An important elemental fact overlooked!" exclaimed the salesman. "That seems strange. What fact can there possibly be that has failed to receive its full share of attention in the voluminous discussions between capital and labor during the past fifty years?"

A Real Mutuality of Interest

"The fact," replied the manufacturer, "that the interests of those engaged in industry, whatever the nature of the functions they exercise or of the service they perform, are identical, not dissimilar, and therefore that their relations should be harmonious, not antagonistic. It has long been customary to look upon industry as a field of conflict occupied by two opposing forces each doing its utmost to cripple, overpower, and even annihilate the other; but the employee representation plan makes production the chief end of industry and is also predicated upon the idea that the human beings who form the two parts of the industrial system have motives and purposes that are common and cannot be otherwise."

"I think I see the drift of your thought," said the salesman. "Something ought to be done to eliminate the discordant influences in industry. An increase of common sense and sanity is certainly needed; but, after all, is the mutuality of interest that you speak of anything more than a pleasing abstraction—something to be desired but quite unattainable?"

"Reflection will show you that mutuality of interest is real," replied the manufacturer. "True, it has been given the appearance of an abstraction through confusion of terms, the fostering of class distinctions and prejudice, and unfortunately through a considerable amount of injustice brought about by misunderstanding or engendered by greed. But when stated in simple language it seems altogether practical. Those who provide capital to organize and carry on an enterprise want a return for their investment, which in the final analysis is compensation for service. Those who supply technical and administrative skill want salaries or other emoluments, which are often meager enough in proportion to the service rendered in developing economical processes of manufacture, finding markets, co-ordinating activities of all kinds and, in short, giving workable form and utility to the enterprise. Those who contribute the labor needed in production want reasonable assurance of employment as well as the assurance of wages commensurate at least with a standard of living which is recognized as decent. In the mingling and harmonizing of these natural wants lie the common

* Mr. Broderick's first business experience was gained by serving for three years as confidential secretary in the executive department of Marshall Field, where his duties brought him in personal contact with Mr. Field. Subsequently he was employed by the Worthington Steam Pump Company, and by the General Electric Company since its organization. His connection with this concern has been as analyst on its manufacturing staff with supervisory duties relating to cost, inventories, and production. Throughout this long business and industrial experience he has been a frequent contributor to newspapers and magazines. His writings have dealt chiefly with economic subjects such as standardization and the cost of living.

sense and sanity that you speak of; and it is common sense and sanity that men and women everywhere always prize and devoutly pray for. In the past there has been fear of organized exploitation, fear of wage-slavery, fear of many direful things which, if brought about, could not be of permanent benefit to any class. Lurid pictures have been painted of the autocratic exercise of power in industry. Such exercise of power must of course be as futile in industry as it is elsewhere."

AUTOCRACY IN INDUSTRY

"There has certainly been a vast amount of talk about autocratic rule," the salesman observed, "and I am not sure that if I were asked to do so I could state the meaning of the term, at least as it is commonly employed. The talk at times has seemed to me to border on hysteria."

"Autocracy, my friend," the manufacturer explained, "has sometimes been taken altogether too seriously, even by people whose habits of thought are temperate; for autocracy is a failure and has always been a failure. I doubt if it is necessary to fight it, except to hasten its destruction in order to prevent temporary damage; for, given time enough, it is self-destructive."

"What is the precise connection between such autocracy and the employee representation plan?" asked the salesman.

"The answer to your question is suggested by applying to modern industry the words of Genesis, 'Let there be light!'" the manufacturer replied. "The employee representation plan calls above all other things for light—for the kind of guidance that comes from a marshaling, sorting, and weighing of simple facts. It requires the substitution of reason for bickering, and, aside from the force of reason and of good example, dispenses with force in any form, and, therefore, its effect must be to prevent the development of autocratic tendencies in anyone."

"In anyone!" exclaimed the salesman. "Do you mean that autocracy is not confined to kings and captains of industry?"

A PREVAILING NOTION

"The prevailing notion," the manufacturer replied, "is that kings and captains of industry have a monopoly of it; but prevailing notions are not always reliable, being based largely upon hearsay, which is a composite reproduction of truth and error, with error often predominating. Autocracy may be compared to a coarse weed that is indigenous in a variety of climates. No environment or social status is peculiarly favorable to its growth. It seems, in fact, to be a perversity which is apt to be manifested in any human being anywhere and under any conditions and for which intercourse is the usual corrective. Autocratic tendencies and practices are often as much a characteristic of those who have little power as those who have much. You, of course, recall the school bully with his high-handed methods. Passing over as of little moment the particular forms in which his desregard of the rights and feelings of others is shown, and viewing him as a type, exactly why is he feared, disliked, and avoided when it is possible to avoid him? The answer is that his viewpoint is distorted. He fancies that he can best gain his ends through force."

"My recollection of the school bully is clear enough," replied the salesman, "but I never thought him vicious."

"As a rule he is not vicious," the manufacturer agreed, "he is merely an embryonic autocrat with no understanding of the meaning of human relations. Contact with other boys frequently develops in him that understanding, causes a shifting of his perspective and gives him a clue to the value of comradeship based upon mutual service; and presently, if endowed with sagacity enough to follow the clue, he sees for himself that it is easy to be a bully but that it does not pay to be one.

WHAT OF THE LABOR ORGANIZATION?

"To return to industrial matters, however, some day even the labor unions, which are entitled to a world of credit for demonstrating the value of teamwork in industry—by clumsy methods and in a limited way, to be sure—may discard the autocratic tactics that make them obnoxious and as a consequence become an accepted factor, and on that account a factor of increased usefulness, in the promotion of progress. Such a reformation may be brought about gradually as the men who affiliate with the unions are afforded opportunity to see from a variety of viewpoints the problems that for a long time they have seen from but one viewpoint. And I am certain from my experience that more is to be gained by helping to develop so needful an opportunity than by attempting, openly or covertly, to break up the unions. Organizations of labor apparently have had a mission more or less valid, and they are destined either to perish because the mission has been fulfilled, and therefore there is no need of concerted opposition to them, or to survive with improved formulas, an expanded programme and, as intimated a moment ago, with capacity for service which will be cordially welcomed by those who now think their influence wholly maleficent."

"I cannot guess the nature of your experience," the salesman observed, "but as for myself I am evidently now having the rather novel experience of talking with an employer of labor who has not been embittered by the unions. I imagine you see no objection in principle to those organizations?"

"What objection can anyone see to organizations of labor in so far as their work is educational and constructive?" asked the manufacturer. "Hostility to unionism, as such, has been a mistake, a very costly one, too, in the effect which it has had of keeping apart people with kindred interests. In common with most employers of labor I deplore the weakness of the unions. Lack of wise leadership seems to be their chief drawback. With a modern Moses to show them the way out of the wilderness of economic fallacy where they now flounder, content for the most part to be merely a menace, it is not unlikely that they would become effective

agencies for good. It is, of course, but just to say of the man who now has the confidence of millions of industrial toilers in this country that he is not devoid of merit as a leader. With a certain native adroitness, combined with downright devotion to his cause, he has long exerted a steadying influence on the activities of organized labor, and industrial evolution has been retarded less on that account than it might have been with a man of different caliber in his place. Nevertheless, his attitude appears to be mainly that of a fighter —the militant chief of a clan with wrongs to redress. It is the incongruity of such an attitude on the part of any one rather than anything malicious about it that makes the judicious grieve; for clans, cliques, and classes are altogether alien to industry, the basis of which is co-operative effort. But we are digressing somewhat. I started to tell you something about the employee representation plan, and I may say with modesty that I ought to be qualified to do so."

The Need of Facilities for Conference

It was at this point that the manufacturer volunteered the information that he was the president of a corporation operating a group of plants in the Middle West. He explained that the employee representation plan had been introduced by him in all of these establishments, and that therefore the subject was one of his hobbies. I was the only occupant of the compartment besides the two individuals named and had hitherto been a silent auditor, but now I remarked that, having studied industrial problems somewhat, I had been absorbingly interested in all that I had heard. Giving the salesman a nudge I added that we had evidently been entertaining an expert unawares, and, with fresh cigars lighted, the dialogue was resumed:

"Perhaps I am less of an expert than an experimenter," responded the manufacturer. "The employee representation plan is still on trial in our plants. Although I have boundless faith in it as a means of promoting good-will, I am scarcely enthusiast enough to look upon it as a remedy for all the ills of industry. Its outstanding virtue, as I have already pointed out, is that it gives to normal human relationships an emphasis or setting that makes them clear; and that clarity is all that has been needed to induce unrestrained, amicable, and easy intercourse with a spirit of mutual trust and wholesome interaction."

"What are the main features of the plan as now in operation at your plants?" asked the salesman.

"I shall describe them directly," the manufacturer replied, "but first I should tell you what led us to adopt the plan. For years the major portion of my time was employed settling or trying to settle disputes between our company and its employees. The alleged grievances that occasioned these disputes were manifold. Piece rates were too low. Hours of labor were too long. Members of labor organizations were discriminated against. Foremen were arbitrary and unjust. The company was unscrupulous, oppressive, and grasping. The fact that in many cases the grievances enumerated were imaginary or based upon incomplete or garbled data afforded us little or no consolation, as the dissatisfaction with conditions grew in volume and intensity from month to month and from year to year with steadily increasing cost of production and steadily diminishing profits.

Strikes and Lockouts

"There were periodical strikes which were fought by us, as we could do nothing else but fight them, and these we invariably won, but in each case the effect of the triumph, never achieved without some cost, and often at an enormous one, was to create resentments which made it easy for chronic trouble-makers to precipitate another strike. Our situation was not unlike that of dwellers near an active volcano from which an eruption more or less violent might be expected at any time. A week rarely passed in which a walk-out at one of our plants was not threatened.

"One evening as I was sitting in the library of my home an idea came to me which was simple enough in itself but had fruitful consequences, as you will presently see. I had been greatly depressed as a result of having witnessed that afternoon a general walk-out at our largest plant, which was afterwards shown to have been occasioned by the most trivial kind of a circumstance. Reviewing certain incidents associated with pleasanter epochs of my life, I recalled among many other things that while in college I had gained the special approbation of my instructors for analytical work. I now thought that if I really possessed a brain capable of doing anything in the way of linking cause and effect I ought to make use of it in seeking a solution of the nerve-racking problems confronting me as a manufacturer. So with the termination of that senseless walk-out, which happily marked our final disagreement of any moment with labor, I ceased for the time being to be an administrator and became an analyst.

"I spent a month in the workrooms of our different plants mingling freely with the men and women there employed. I asked them questions about their tasks, exchanged views with them concerning shop regulations and conditions, and, by the most engaging methods that I could think of, encouraged them to tell me about their grievances in their own way. Some I found suspicious and disposed to be non-committal. Others readily gave me their confidence.

What One Study Disclosed

"On the whole I obtained a considerable quantity of information of a character which had never before been available. Making a diagram of the grievances, the recital of which I had taken such pains to elicit, I studied them thoroughly, earnestly, and without bias. I traced each grievance not only to the circumstances with which it appeared to be immediately associated but backward to its source. Then, in imagination, but with the aid of facts which were obvious, I pursued a forward course with it, assimilating data, as I proceeded, relating to a variety of collateral influences, and finally I reached a point where the grievance took the form of

the customary murmurings and mutterings, or found expression in a strike. The results of my research convinced me that the underlying weakness of our enterprise was lack of knowledge. The management lacked knowledge of the aspirations and needs of employees. Employees lacked knowledge of the responsibilities and motives of the management. Clearly, therefore, we needed facilities for conference so that knowledge would be diffused. The situation assumed a simple aspect."

"Economists, labor leaders, and politicians," remarked the salesman, "had much to say during the war about collective bargaining, and a great deal is still heard concerning it. Evidently it is something of that sort that you have."

A Confusion of Terms

"You have repeated one of the phrases I had in mind when I spoke a short time ago of confusion of terms," the manufacturer replied. "The man who first made intercourse between corporations and their employees odious by calling it collective bargaining must have been a Yankee trader skilled in practices universally accepted as normal a generation ago but now obsolete. The Yankee trader had his day and seems to have prospered while it lasted, but with the rapid change of business concepts which has taken place in recent years he has become archaic. No, our plan is not based upon collective bargaining or bargaining of any sort. A bargain implies an advantage gained by someone at the expense of someone else, whereas it is our belief that mutual advantage, besides being a consummation devoutly to be wished in a moral sense, must be the bedrock of industrial efficiency. We meet with our employees at frequent intervals, not in a spirit of controversy, not with any wish to mislead, outmaneuver, exploit, or bargain with them, but rather to obtain their help in weighing vital facts; and the steps shown by a process of natural selection to be expedient or essential in order to promote the good of the enterprise are openly agreed to as representing the crystallized judgment of all concerned.

"The fairness of spirit which we have been successful in bringing about," the manufacturer continued, "was illustrated once by a case in which certain piece rates were cut in response to a suggestion originating with a group of workers directly affected. These workers had faith that their suggestion would not lead to a permanent reduction of earnings. Seeing that the established rates were too high they wanted them reduced on that account and in the belief that other rates found too low would be as readily increased.

"Your conversion to industrial democracy," said the salesman, "must have seemed a rather sudden one. Ordinarily such a change of heart is apt to create suspicion—to cause employees to keep their eyes open for a trap or a concealed club!"

"Yes, yes," the manufacturer assented, "I quite appreciate that point. Failure to win the good-will of workers is the nightmare of employers who wish ardently for improved economic conditions without perceiving the need of any change of managerial methods. That motley mixture of concern and self-complacency had long kept us in a condition of painful stagnation, and what you call a change of heart was nothing more than fully opening our eyes and seeing where we stood. It was a case of simple revelation like that experienced by the driver of a vehicle on a dark night when he finds he is in a rut. Thus the employee representation plan was not adopted by us wholly because of a belief that our employees needed reformation, although their particular shortcomings were obvious enough, but in the main because we were convinced that our system of management was far from perfect and called for amendment. It was that humility, if I may so call our state of mind, combined with the change of procedure inaugurated, that so speedily gave us the results sought. Had we been merely industrial Pharisees hatching a new scheme to make our employees righteous instead of stewards honestly seeking the prosperity of everyone connected with the enterprise, it is altogether likely that we would not have been trusted, and the representation plan would have been opposed or accepted sullenly and with a secret determination to defeat its purpose."

"Do you know," said the salesman, with the naive candor of one to whom an idea already vaguely perceived has suddenly become clear, "that humility has often struck me as a very desirable trait for leaders of industry to have—one, I mean, which must be helpful to them in the performance of their managerial duties."

"It is more than desirable," the manufacturer declared with emphasis. "Without it men filling administrative jobs are apt to be costly bunglers with power, and liable, unfortunately, to obscure for a time the damage they do. A spirit of open-mindedness and humility is associated with the most brilliant and useful engineering achievements in fields hitherto developed, and it must be relied upon to win the day in the relatively new and highly important field of management engineering."

Methods of Wage Payments

Responding to a casual comment of mine, the manufacturer here recited his experience with the piece-rate, time-rate and premium methods of recompensing labor. The piece-rate method, he pointed out, had given splendid results for a short time, but had been rendered virtually useless by the tactless and blundering way in which some plant managers had sought to apply it. Hence, piece-work had finally ceased to be any more efficient in practice than day-work done with ordinary diligence.

This talk about methods of payment for labor, though of interest in itself, would not be relevant if reported verbatim. It is referred to in this brief manner because the alleged failure of the piece-rate method gave practical significance to the human element in industry, an enlightened regard for which, the manufacturer explained, was the main feature of the employee representation plan.

(To be concluded)

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Measuring the Effectiveness of Management

This Study Proportions Management Resources as: Organization 35 Per Cent, Technical 20 Per Cent, Utilization 45 Per Cent

By WILLIAM B. FERGUSON*

Consulting Engineer

IN the following discussion of measurement effectiveness is a much better word to use than efficiency, because the present article is not going to deal with ordinary efficiency at all. The efficiency of the management of a plant might seem the ratio between the energy *usefully* expended (resulting in output) under the management actually in control and that expended under an ideal 100 per cent or perfect management, the total cost expenditures in each case being the same. How can anyone say what 100 per cent management is? What is perfect management? Who knows? That which today seems to you to be the best managed factory and to excel all other plants in every management factor may be a very poorly managed plant in your judgment 10 years from now, by reason of unforeseen improvements of which management cannot now take advantage, simply because management does not know at present of their existence or probable discovery.

What is Management?

The present discussion will depart from the scientific method for the moment, the method so ably adopted by A. L. De Leeuw in his convincing article on "The Final Measure of Industrial Efficiency,"[1] and the word "management" will be used in a very restricted sense, as meaning that branch of the management of a particular establishment or factory in an industry which is within the control of the manager. Management may be employed as a broad term embracing almost everything, such as financing, purchasing, storeskeeping, production, human relations, marketing and salesmanship, collection of bills, advertising and all the other factors that affect the success or failure of a concern. Frequently, however, some of these elements are not controlled by the manager. Hence we would be vain indeed to attempt to surmise or conjecture, much less try to demonstrate, that management is a thing to be weighed in the balance and marked up as 60 per cent or 80 per cent or 92 per cent efficient. Our limited field of discussion will deal only with that phase of management which has for its object the production of the maximum of output, at a minimum cost, under normal market conditions.

We who are so fortunate (as we think) as to have been trained as engineers, are apt to believe that all knowledge and all learning and all experience can be expressed in engineering terms, and that the scientific engineering method of attack or approach (attack if a palpable evil—approach if a debatable issue) is the only way to go after a proposition. After many failures to interest doctors and bankers and preachers and movie actors in engineering terms and methods, I have been forced to learn their various languages to the extent of which I was capable, and to forget a lot of things I was taught about "Knowledge is power" and "All things come to him who waits," and similar deceptive aphorisms. Knowledge is not power at all, though the *use* of knowledge and its adaptation to practical, everyday conditions are a source of power. On the contrary, knowledge is often the antithesis of power, often a source of failure and regret for the individual, although his descendants may be proud of their ancestor's knowledge and mention it in their family history. The appeal to self-interest, *argumentum ad hominem*, still remains the most powerful form of appeal to the average executive.

The Method of Deducing Management Laws

Let us go back to the theme—the effectiveness of management. Nearly 24 centuries ago Cincinnatus, plowing in the field, got a message to come at once to Rome and take charge of affairs, as Dictator, the Man of the Hour. He proceeded, and we presume in the most efficient manner he knew—possibly at the rate of four miles an hour—with his team. But how inefficient we would consider that journey to Rome in these days, when an aeroplane would carry him swiftly to the capitol at 100 miles an hour! Cincinnatus was only 4 per cent efficient in his transportation, and yet in those times they probably considered him 100 per cent efficient. Hence we must use another term, and considering him as efficient as the means at the time permitted, we will call him 100 per cent effective, under the existing conditions and with the knowledge then available.

A recent issue of the magazine *100%* speaks of the

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In the following eleven years he served as naval constructor, United States Navy, and during a part of this period represented the Navy Department in the raising of the Maine in Havana. In 1914 he designed and installed a uniform system of accounting and cost keeping, at present used in all navy yards.

In 1915 he resigned from the navy to become production manager of The Remington Arms Company. He returned to shipbuilding in 1917, and for nearly two years was assistant to the president of the American International Shipbuilding Corporation, in charge of production engineering. He is now engaged in consulting engineering work.

[1] Management Engineering, September, 1921, page 141.

Waste Report of the Committee of the American Engineering Council as follows:

> There is much in the report of the Committee on the Elimination of Waste in Industry that deserves the serious consideration of management. The report has been criticized as a mediocre and unscientific document. It has been accused of what the logicians call the fallacy of composition—of drawing general conclusions from a too limited investigation of facts.

The article starts out with voicing the views of the inductive reasoners, who demand, of course, additional facts from which conclusions can be drawn; but later it goes over to the side of the deductive reasoners and praises the executives who believe that "planning" is the root, source, and container of all management's ills. From this surmise or belief, the article proceeds very strongly as follows:

> What is the main cause of waste and inefficiency? It is not conditions, it is not railroads, nor labor, nor capital, nor management, nor is it primarily Congress. It is caused by thoughtlessness on the part of these groups—lack of intelligent planning, absence of co-ordinated effort, selfishness.

Newton's universal laws of gravity and motion were discovered by deductive reasoning. This reasoning from general principles or theories to particular cases requires imagination and courage, for to the usual analytical engineering mind such arguments are not convincing. It takes a long time and years of experiments to substantiate the most plausible theory. Eighteen years of experiment and trial in modern methods of management have elapsed since the publication of F. W. Taylor's "Shop Management," with its deductions of governing principles of management. Some of those principles remain unchallenged, but the mode of application has varied tremendously in different plants. The science of management (knowledge) has advanced farther than the art of management (use or employment of knowledge).

For my part I am content at present to recite a few facts brought out in past studies of metal trades plants —to mention a few statements showing the attitude of executives toward the whole matter. These were made while we were getting facts from 32 plants for the use of the Waste Committee.

How to Measure Effectiveness

The Committee on the Elimination of Waste in Industry, on which I had the honor to serve as a Field Director, devised, designed, and put forth for our use one of the most remarkable documents in all the history of management, the *Questionnaire*. It is so simple, so complete, and so useful to any executive in any factory that after eight months' study of it I am convinced that nothing of the kind equal to it has yet been advanced in the science of management. Its chief value is in starting executives to think rigorously about the conditions in their plant and to stimulate an interest in possible improvement.

This questionnaire is an examination paper of such utility and completeness that any executive can use it as a guide to measure the effectiveness of his management, just as the banker uses his balance sheet and financial statements to measure his effectiveness.

To show the practical application of the questionnaire as a measure of effectiveness, I have selected three metal-working plants with which I have been acquainted for several years, all making similar products of such a nature that a common unit of output can be established and actual costs of production compared. A close study of these three plants, their organization, methods, developments, and improvements, over a period of from two to ten years, enables us to analyze the numerous management factors in a way that would not be possible from a casual or superficial study of a few days. I regret that at present I am not at liberty to divulge the names of the concerns, the products, and the financial statements and cost records which form the basis of these statements of facts. Some day I hope that similar comparisons may be published by trade associations, not only for the benefit of the industry as a whole and for the benefit of the individual members, but for the benefit of all executives.

The Plants from which Facts Were Selected

These three plants are selected out of a large number of metal-working plants as illustrating in a most specific and intensely interesting way the value of the questionnaire in measuring the effectiveness of management. When the questionnaire is further developed and improved for various branches of industry, it should prove its worth conclusively to any executive who is really interested in improving his effectiveness. Until I am at liberty to give actual figures the reader will have to accept as a substitute the following data of a relative or comparative nature, which for practical purposes may be easier to visualize than the real figures. Of these three metal-working plants, one is very large for its line of work, one is large, and one is medium in size. A study of pre-war conditions, war-time conditions, and present conditions has been made in these plants, with a view to gaging the effect on productivity per employee and actual cost per finished unit of output caused by changes for better or worse in all the management factors covered by the questionnaire.

Plant No. 1 (very large) will be marked for convenience as 100 points in size, or number of employees (as of October 1, 1921); 100 in cost per unit (not including profit); and as 100 in total effectiveness.

Plant No. 2 (large) on October 1 would then be 70 in size, 130 in cost per unit, and 77 in effectiveness.

Plant No. 3 (medium) on October 1 was 40 in size, 150 in cost per unit, and 67 in effectiveness.

The analysis of management factors and the comparison of these factors as to methods, etc., right through the questionnaire for the three plants give us a basis for weighing the relative importance of the management factors.

But, convincing as it might possibly be, we are not content with this plan alone, for we want to note the progressive influence of management factors in each plant, as changes have been made. For example, if in any plant in June, 1919, the cost per unit was 100, and in June, 1920, the cost was 80, we would want to compare all management factors for the two periods

and see wherein they were different and account for the improvement of 20 per cent. Our studies enable us to make such comparisons for each plant in a way that gives us justification for weighing or evaluating management factors in this branch of the industry. Our individual experiences and our plain reasoning powers tell us that certain practices are wrong and ineffective. You do not have to give a hundred men, assorted as to age, health, color of hair, etc., each a big dose of strychnine to prove that strychnine in excess will surely kill you. No more do you have to analyze the effect of a certain deadly storeskeeping system on 100 or even 10 plants to prove to an experienced executive that it will ruin the efficiency of any plant of any kind to which it is applied.

HISTORY OF THE THREE PLANTS

For convenience in pursuing the study of cause and effect in management factors and production per employee, we will set down in round numbers (see Table 1) the history of the three plants, as of the fall of each year, for the three years of 1919, 1920, and 1921, together with a few other figures for plant No. 1 prior to the war. The figures of Table 1 are relative and not absolute. They represent points and not percentages.

TABLE 1. INDEX NUMBERS FOR THE THREE METAL-WORKING PLANTS'

PLANT	1921	1920	1919	1917	1912
Size					
No. 1	100	160	200	150	100
No. 2	70	90	110	...	...
No. 3	40	70	80	...	...
Cost per unit					
No. 1	100	130	160	95	80
No. 2	130	150	180	...	...
No. 3	150	170	200	...	...
Wage scale index	100	115	115	70	50
Apparent effectiveness of management					
No. 1	100	77	63	105	125
No. 2	77	67	56	...	...
No. 3	67	59	50	...	...

[1] Table 2 corrects for variations in cost of materials and wages.

The combined experience of numerous executives in this branch of industry has been drawn upon to estimate what management factors are very important, what are of minor importance, etc., in order to make a tentative or "trial and error" solution of the problem in hand. This step, however, as I shall show later, is not absolutely essential in order to weigh the management factors, provided we have determined what procedure or method in this or that factor invariably gives the best result, other things being the same or equal. There, again, we draw on the experience of numerous executives, foremen and even workmen in the industry, supplemented by records of similar studies of thousands in other industries. Certain elements are obviously so important, and it is so well established as to what is good and what is bad practice in these elements, that we have no fear of calling them, as we proceed, the major factors in production.

THE QUESTIONNAIRE OF THE WASTE INVESTIGATION

In the September issue of MANAGEMENT ENGINEERING the 46 main divisions of the questionnaire were briefly described by Fred. J. Miller. These 46 elements may be called the management factors which we wish to weigh and evaluate. If our weighing is correct, or approximately so, that is, if we give to these 46 factors their relative weights or importance; and if we evaluate the factors correctly, that is, if the effectiveness of each factor in each plant is gaged correctly or approximately so, then we arrive at a figure for the total effectiveness of management of the plant which is approximately correct.

These 46 management factors are repeated for greater clearness in chart form (in Fig. 1); and this chart attempts to show, though it shows it somewhat imperfectly, the relation or interdependence between all the factors. We have indicated on the chart, by lines connecting the blocks and by arrows, for example, that:

Labor turnover K-4 is influenced by *K-2* (type of organization) *K-7, K-9, K-11, K-10, K-6, K-21, K-20, K-13, K-14, K-15, K-17, K-18.*

Strikes and labor disturbances K-17, K-18 are influenced by *K-16, K-15, K-12, K-14, K-13, T-1.*

Cost keeping U-7 is influenced by *U-4* (planning), *T-7, U-12.*

Reduction of idle time of men *U-8,* and also of machines *U-3,* are influenced by *U-4, U-7,* and so on.

In reality the interrelations are more complex than are shown on the chart, which is merely illustrative of the "dependent sequence" of management factors.

This particular chart is the actual chart for Plant No. 3, above discussed, with each block shaded to represent waste or inefficiency; the total waste being 42 per cent leaves 58 per cent effective effort, considering another plant as 100.

On this chart the border lines for the blocks representing eight major factors are heavy lines, as follows:

Factor No.	*Description*
1. *K-19*	Industrial relations or personnel functions.
2. *K-12*	Labor turnover, analyzed by causes.
3. *K-17-18*	Labor unrest and strikes.
4. *T-7*	Product design.
5. *U-4*	Planning.
6. *U-7*	Cost keeping.
7. *U-11*	Purchasing.
8. *U-16*	Inspection.

As A. L. De Leeuw says: "Organizations do not, as a rule, work in series but in parallel," or in effect, "The management factors are usually in parallel and not in series," which, of course, is true in speaking of two such large divisions as production and sales; but with reference to the smaller divisions shown on the chart, many factors are dependent either directly or indirectly on other factors, and most of the factors are therefore in series. In fact, in the broader sense, production (quality, speed, and cost) influences sales tremendously.

The indirect and tangible effects of each factor in management upon all other factors produce what may be "felt" as the "atmosphere" in the plant which one does not get all at once, nor from merely talking to executives. Here is an opportunity in the field of management for a Herbert Spencer or a John Stuart Mill to apply the Einstein theory of relativity, because the *real* situation in a plant, with respect to the workers with their hands and tools, their effort and their interest in the product of their hands, their atmosphere and spirit to sing or to mope, their confidence in the management or their distrust, is seldom what it *seems* to be from a study of organization charts and executive notices posted on bulletin boards. There is no method of engineering to measure the hopes and aspirations and spiritual effectiveness of the soul of man, no mechanical instrument that can pierce the *ego* of emotions and define the real reasons why Bill Brown says: "I like to work here, have been here 20 years." On the other hand, we do know that the *spirit* of the management is reflected all through a plant, down to the common laborers, and that if things run smoothly in all departments, without friction and with everyone interested in the effectiveness of the plant as a whole, there is little room for a spirit of distrust, jealousy, or grouchiness. The plant effectiveness is the summation of the effectiveness of all individuals.

A Mathematic Method

Bearing in mind the limitations of the engineering method of analysis of effectiveness, we can now proceed to a purely mathematical way of estimating the relative effectiveness of the various elements of:

1. Organization
2. Technical facilities and knowledge
3. Utilization of knowledge and facilities in a plant

Plant No. 1 has enjoyed a permanency of policy and personnel, and has an organization which provides quite definitely for the performance of each function by someone who knows how. Plant No. 2 is a newer plant, characterized by an effort at continual improvement along many lines, but weak in certain factors shown in comparison given later. Plant No. 3, although a very old plant, has suffered from internal politics, from changes in personnel and policy, and in the past from lack of a thorough study of such management factors as purchasing, storeskeeping, and routing. Men like to work in plants 1 and 2, but until recently men did not like to work in plant No. 3.

The facilities of manufacturing in plants 1 and 2 are not very different—they are both very good—but the layouts are not the best that could be devised for handling materials. The facilities of plant No. 3 are less modern and yet are not sufficiently behind the equipment of No. 1 and No. 2 to account for over 2 per cent difference in the total cost of product. Improvement in plant No. 3 has been very marked in the past two years in many respects, but very slow in others, the net increased effectiveness being small.

If we take the three main divisions of the questionnaire: Organization, Technical, and Utilization as the unknown values, K, T, and U, and wish to measure their relative importance or weight (the sum of $K + T + U$ being 100 points) we have enough data from these three plants to do so by a method of trial and error. For we can fairly well assume various values for our first trial, and estimate the improvement in each division for each plant over a two-year period. By also using different figures for these estimates (which are really determinable within certain *limits*) for other trials, we finally arrive at what may be called mathematically "the most probable values" of K, T, and U.

The typical formula for the effectiveness (E) of a plant would be:

$$aK + bT + cU = E.$$

Where

a = per cent effectiveness of Organization factors
b = per cent effectiveness of Technical factors
c = per cent effectiveness of Utilization factors
E = total or resultant effectiveness of management

Calling the effectiveness 100 of plant No. 1, as of October, 1921, and allowing for variations in wages and material beyond the management's control, we are able to replace Table 1 with a revised table (Table 2) for effectiveness of plants 1, 2, and 3 for three different periods one year apart.

TABLE 2. EFFECTIVENESS OF THE THREE METAL-WORKING PLANTS

Plant No.	1921	1920	1919	1917	1912
1	100	88	72	74	63
2	77	77	65	..	..
3	67	68	58	..	..

From our studies of the three plants, as previously indicated, we know that the equations for plant No. 1 cannot be very far from the following:

$$(1921)\ldots\ldots\ 1.00\,K + 1.00\,T + 1.00\,U = 100.$$
$$(1920)\ldots\ldots\ .90\,K + .90\,T + .85\,U = 88.$$
$$(1919)\ldots\ldots\ .80\,K + .80\,T + .65\,U = 72.$$

Plant No. 2 equations:

$$(1921)\ldots\ldots\ .70\,K + .80\,T + .80\,U = 77.$$
$$(1920)\ldots\ldots\ .70\,K + .80\,T + .80\,U = 77.$$
$$(1919)\ldots\ldots\ .60\,K + .80\,T + .60\,U = 65.$$

Plant No. 3 equations:

$$(1921)\ldots\ldots\ .70\,K + .70\,T + .65\,U = 67.$$
$$(1920)\ldots\ldots\ .65\,K + .70\,T + .70\,U = 68.$$
$$(1919)\ldots\ldots\ .60\,K + .70\,T + .50\,U = 58.$$

Solving these nine equations for the most likely values of K, T, and U, we get:

K = 35 points
T = 20 "
U = 45 "

Total 100 points

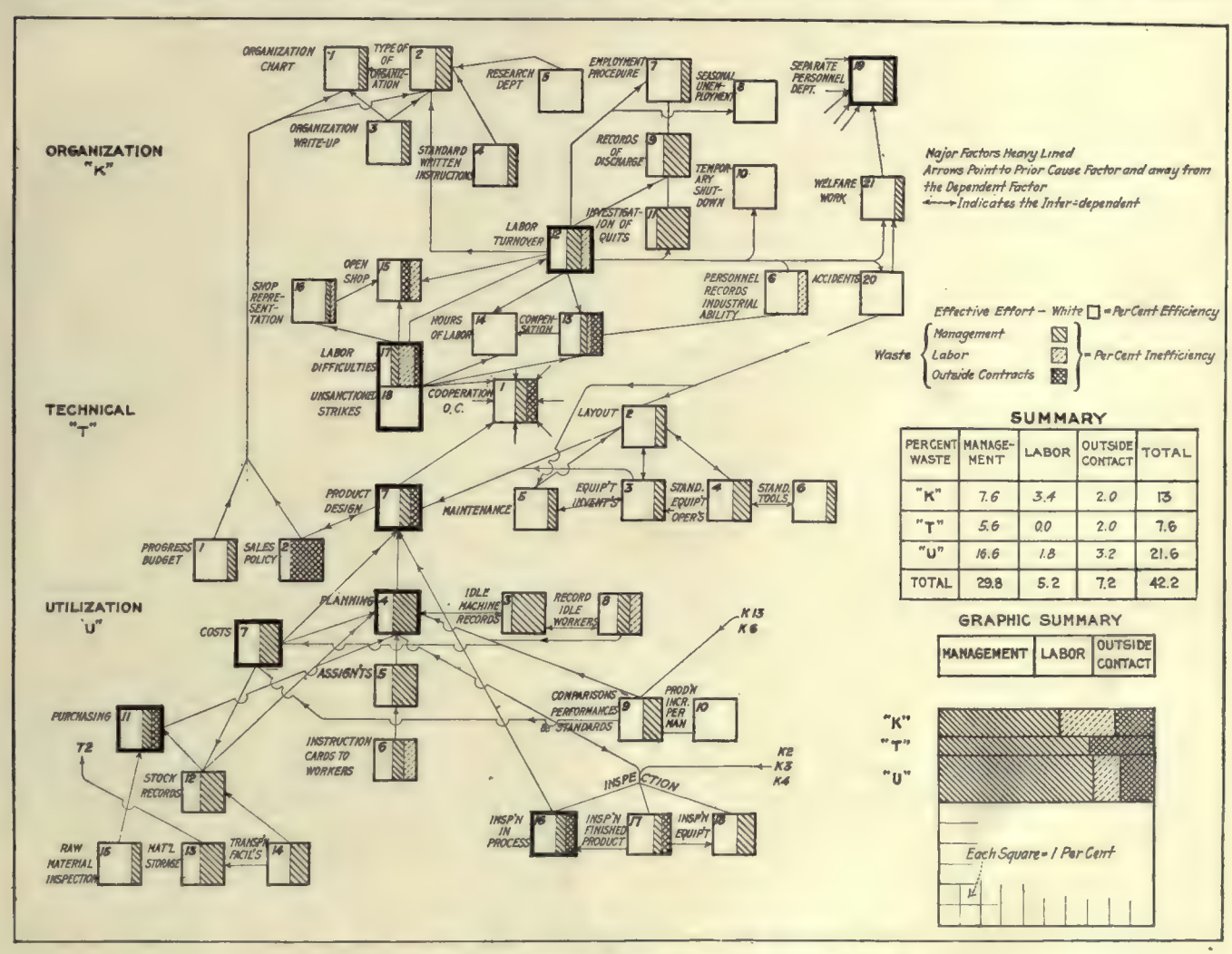
That is to say, if the data obtained in this industry are reasonably accurate, and if the experiences and views of numerous executives in the industry are valuable enough to use as a foundation for judging, then our conclusions are sound, namely:

Organization—meaning the design of the personal relations, the assignment of functions to departments

and executives, the means used for promoting confidence and loyalty between employer and employed, and allied matters—comprises about 35 per cent of the resources of management for effectiveness.

Technical Facilities and Knowledge—meaning the ability and industry of the technical employees (as draftsmen, engineers, etc.), the layout and design of buildings, equipment, tools, etc., the design of product. instructions for manufacturing, etc.—comprise about 20 per cent of the resources for effectiveness.

Utilization of facilities, knowledge, and organization



PERCENT WASTE	MANAGEMENT	LABOR	OUTSIDE CONTACT	TOTAL
"K"	7.6	3.4	2.0	13
"T"	5.6	0.0	2.0	7.6
"U"	16.6	1.8	3.2	21.6
TOTAL	29.8	5.2	7.2	42.2

FIG. 1 CHART SHOWING THE WASTE FACTORS OF PLANT NO. 3

—which includes training of workers, assignment of jobs or tasks, records of workers and machines, methods of purchasing, storeskeeping, routing, dispatching, etc. —comprises about 45 per cent of the resources for effectiveness.

Having arrived at a reasonable relative weight for the three main divisions of management factors, we can in a similar way proceed to break down these divisions into the 46 factors of the questionnaire. We cannot go very far wrong for the general result in mind, although each element may be in error, as the law of averages operates to prevent any large error in the *total* figure of a plant's effectiveness. To those who do not believe in the mathematics of "probability of error," it will be sufficient proof simply to take the figures given for the 46 factors and deliberately change them to suit their fancy, and then work out the final figure for effectiveness with the new values. It will be seen that no *reasonable* changes in the units will affect the final result very much.

Only one more important feature of the above method of measuring the effectiveness of management in a particular plant remains to be discussed, that is: How to estimate the effectiveness of a particular factor compared to the same factor taken as perfect in another plant. Possibly enough has already been said to indicate the general method of approach with respect to the improvements in certain features or factors in the three plants analyzed. If not, we may amplify a little, as follows:

Plant Q in 1918. The output per man-hour for all employees was 100 (Index number). It is to be borne in mind that there are 46 management factors, any one of which may be improved or changed without any immediate material change in the other factors. If factor No. 6 is changed (improved) to the method used in another plant which has made a successful study of this factor, and if the result of applying the better method is an increase in effectiveness (output per man-

hour for all employees) from 100 to 102 (Index number) then it can well be said that an improvement of x per cent in factor No. 6 has caused an improvement of 2.0 per cent in the total effectiveness of the plant. If factor No. 6 is rated at 4 points out of 100 for the whole plant (weight or relative importance) then it can be said that this factor has been improved 50 per cent in effectiveness.

$$\frac{4x}{100} = \frac{100 \times 2}{100}, \text{ or } x = 50.$$

After analyzing many specific cases over a period of years and exchanging experiences with others as to definite increases in production due to definite causes, one becomes quite as confident in telling what is wrong in a plant as the physician is confident in diagnosing a disease from well-recognized symptoms. There are certain fundamental laws of nature which cannot be violated without a loss of personal effectiveness, and if the violation is carried to excess, real illness results. Ages of human experience, recorded and recognized, are at the physician's disposal, upon which he bases his diagnosis and prescribes a remedy. For factory management, engineering, and human experiences have piled up fast in recent years; a great deal has been recorded and a vast deal more is somewhere available that might be recorded for the benefit of industry and humanity. Even now, with the present reluctance on the part of many executives to contribute their experiences for the benefit of their competitors (as they view it) there has been presented in recent years enough evidence to prove to any experienced executive that in industry, as in nature, there are certain fundamental laws, as inexorable as the laws of nature, which cannot be violated by management without a loss of managerial effectiveness.

Foremen *658.373*

The Foreman's Place in Industry

By RALPH W. IMMEL

With The American Smelting and Refining Co.

IN the past few years there have been countless articles on "educating the foreman," and, if the writer is not in error, some magazines have even devoted whole sections to the discussion. The foreman who had been in our midst since industry started, was suddenly transformed into a curiosity, to be figuratively poked in the ribs and examined minutely. In our zeal and enthusiasm we set ourselves to the task of educating the foreman, with the result that sometimes that bewildered individual was led to wonder how he had managed to "get by" in years past. Because some foremen are harsh and unjust we often jumped to the conclusion that all of them were open to suspicion, and proceeded to make rules and lay down restrictions which, while they controlled the bad, frequently had the incidental effect of hindering the good.

It is the humble opinion of the writer that there is today nothing in greater need of intelligent and conservative adjustment than some of the forms of personnel management and control—those affecting foremen particularly—which sprang up during the war, and which were carried on to an elusive and artificial success on the high tide of enthusiasm and patriotism, which indeed was more of a force with our workmen than is commonly appreciated. But even though those plans had succeeded, by reason, say, of their own soundness, the change in industrial and economic conditions alone would still argue the need of just as drastic a change as is now necessary in this most important branch of industrial management.

A New Conception Needed

Today industry needs the foreman as never before. In many cases freak plans have alienated him, and he does not feel the same interest in his work that he formerly did. Indeed, curious as it may seem, it is patently true that in the old "hire and fire" days the foreman was more a "company man" than he is today. In the old days he used to be the embodiment of authority. He *was* the company, so far as the men were concerned, and the reaction upon him of this attitude of the men was such as to make him the jealous protector of the company's interests and the defender of its policies. The writer would not advocate the return to the old "hire and fire" methods, but he does advocate a study of the effects upon the foreman of the new methods of control.

And yet, is it not true that many of the new forms of employment management had the effect of stripping the foreman, one by one, of those little prerogatives which, to us making the change, seemed trivial, but which in his mind meant the difference between prestige and disgrace, faith and lack of faith, and authority and loss of authority? Undoubtedly, many of them had taken undue advantage of opportunities which their prestige afforded, had abused the trust and faith placed in them, and had become arrogant in the authority vested in them, but instead of using discrimination in the cure we treated the whole lot for a disease which only a few had, and, as a foreman told me: "It was a bitter dose, and a hard one to take."

All Foremen Are Not Slave-Drivers

For fifteen years the present writer has been associated intimately with foremen of all ages, conditions, and nationalities, knowing them both inside and outside the plant or the mine, and he is now at a loss to understand what mental freak caused those of us, with previous experience, who should have known better, to forget or ignore the worth-while points, the rough justice, the unvarying loyalty to the company and its policies characteristic of the majority of foremen, and accept, even for the briefest period, a system, the foundation of which was laid on the unspoken assumption that most foremen were slave-drivers and tyrants.

When a man sees those privileges which he has enjoyed taken from him, when every rule put out by our superiors registers what seems to us lack of faith in us,

the most plausible and natural reaction is a loss of sense of responsibility, which has as its offspring loss of interest and loss of loyalty. This is not the result of socialism or Bolshevism—it is human nature; and this is the reaction we have forced upon our foremen.

Recently in a certain plant a foreman, after reading a new rule, made the remark: "What's the use of being a foreman? They have taken from us everything worth while." There lies the whole story: "Everything worth while." That, to the foreman, means local prestige in the plant and in the neighborhood, a sense of power and responsibility, being entrusted with men and material.

JOB ANALYSIS

DATE

DATA FURNISHED BY

Position	Pay	Training Period	Rating Skilled	Promotion From
			Semi "	Possibilities To
			Unskilled	

Nationality Preference — Why?

Married or Unmarried Preference — Why?

Description of Occupation in Detail

Physical Conditions Surrounding Job

Parts of Body Under Greatest Strain

Other Physical Requirements

Mental Requirements

Moral Requirements

Sense Development in Order of Importance—First Second Third

Negatives—Body Build Which Would Unfit Man For This Work?

Mental Qualifications Which Would Unfit Man For This Work?

Remarks [Here note any extraordinary conditions or requirements connected with this job]

SUMMARY

Number of Men in This Occupation?	Number of Understudies?	Number of Helpers?
What Proportion of This Man's Time is Required in Active Operation of His Duties?		What Proportion in Watching?

What Occupations Are There in Close Proximity to His Field of Work?

Possible Combination With Other Occupations?

Has He a Zone Under His Particular Care as Regards Cleanliness?

What Zone Could He Cover Without Neglect of His Duties?

To What Extent is His Work Dependant on Operating Conditions [Speed of furnace-length of charge haul, etc.]

SUGGESTED TYPE—AS BEING MOST ADAPTABLE TO THIS OCCUPATION

COLOR	Fingers	Walk	Type and Condition
Hair	Finger Tips	Voice	Vision
Eyes	Thumbs	Personality	Hearing
Skin			
Beard			
FORM	Shape of Hand	Texture	Flexibility
Forehead	Size	Consistency	Body Build - Shoulders
Eyes			Arms
Nose	Structure	Cranium	Back
Mouth	Face	Forehead	Legs
Chin			

FIG. 1 FORM USED BY THE FOREMAN FOR JOB ANALYSIS

Now, industry being interested in profits and not in fine distinctions of justice and sentiment, the question naturally presents itself whether the new system has had any tangible results, and in case it has had any bad results, whether the injury has been merely sentimental, only to the heart, or an injury to that which is most important in business—the cash box.

When the spirit is broken, the initiative is gone; when initiative is gone, progress ceases. Industry hires efficiency engineers to "discover" things, which oftentimes the foreman knew all along, but which he felt he did not care to tell. His reasoning is this: everything has been taken from him except his title and his "share of grief." If efficiency engineering is a part of the new scheme, his attitude is: "Let 'em find things themselves. They don't think I am capable of running my men or my department."

While we cannot agree with the justice of this reasoning, no matter how seemingly great the provocation, at the same time we cannot deny the plausibility and existence of it. We have stifled that quality in the foreman which makes him most valuable—the initiative and will to improve, to help, to save.

One of the most efficiently conducted plants the writer knows of "stood pat" through the fever of industrial administration changes. The result is that the foremen still possess the will, interest, and initiative to study their problems—the cutting out of waste motion, the combination of jobs—so that the most critical and careful analysis in this plant has failed to show room for improvement as regards labor efficiency.

In another plant the writer was told by the man in charge that the foremen did not "fire" men enough. This is too often the case. Although by the new system the power of discharge is not taken away, often in our anxiety to retain men in our employ we attached a sort of odium to the discharging of men, even going so far as to intimate that if the foreman had been "on the job" he could have adapted the discharged man to his work in some way or other. Hence foremen have grown to be less critical of their men than their duty to their employers calls for, the result being that inefficient men are kept on the job.

FOREMEN ARE NEEDED NOW

In times of plenty, when we could pay good wages, indulge in every whim in the way of entertainment and other so-called welfare features, and, in short, cater in every way to the workman, then, so long as we came laden with gifts, surely we needed no intercession. At that time we could deal directly with the men, but it is different now. Today, when lack of markets, money, or material forces us to go to the men with plans for economy, short-time weeks, reduction in pay, etc., if we do manage to introduce the change, it is only because the men have no other place to go. When we fail in our attempt, it is largely because we no longer have the interest and co-operation of the natural go-between.

Certainly profit-sharing, bonuses, and special dividends will continue to be necessary so long as management tries to deal directly with the men. Except in rare cases of understanding and real genius, management and the workmen talk different tongues. In spite of everything he can do, the employer cannot remove from his granting of dividends, bonuses, and provision of entertainment and welfare features the taint of largess.

In certain classes of manufacture, where the man works individually and can be paid by his individual output, it may be possible to go ahead without the "old-time foreman," but in the majority of industries there is still gang-work, and, consequently, still a large margin of production directly dependent on the efforts of the men collectively and the foreman individually. It is most commendable for the employer to want to bring

out the individuality of his men and incidentally to get from them more production, for which they in turn receive greater wages. But the class to which this would apply is limited.

The belief of the writer is that we should get on middle ground, that we should neither go back to the old ways nor hold entirely to the new; for, although most foremen are as considerate of their men and are as just as we could wish them to be, at the same time there are enough exceptions to this rule to make it advisable to keep some tabs on them.

The plan which the writer adopted some years past and which is presented below, is not put forward as anything new. As a matter of fact, something of the kind seems so obvious that doubtless many plants have used it as a matter of course and not as an innovation.

Briefly, the plan is based upon the homely hypothesis that the greatest hurt to the foreman has been to his pride, to the belief he holds that he has been belittled in the eyes of his men. Therefore our plan must do away with this condition. The foreman must be to all appearances restored to his former authority.

According to this plan, when a foreman is dissatisfied with one of his men, before discharging him he is required to notify the employment department 24 hr. in advance, and the employment manager discusses the case with him. If an agreement is reached that the man in question should be dispensed with, the foreman is the "dispenser." If, on the other hand, it is mutually agreed to give the man another trial, the man in question is none the wiser. There must, however, be a proviso to this rule allowing the foreman to discharge a man summarily for gross insubordination, but in such cases he must fill in the form later, showing the reason for discharge, the man's rating, etc.

Where the power of discharge has been taken from the foreman, this arrangement gives it back to him, so far as the knowledge of the worker is concerned. And just as the foreman does not feel that his honesty is being questioned when he has to make requisition for and show disposition of material, so he will not resent accounting for men in the same manner.

In this way it can be readily seen how advance notice allows the employment manager to make the best use and placement of men to be laid off, and how humiliation and bitterness are saved the man who is transferred from the job instead of being sent to the employment man with a small slip marked for replacement but with *failure* written in his every step and posture.

The second part of the plan consists briefly of job analysis by the foreman. For this the forms shown in Figs. 1 and 2 are used, which represent the residue or result of probably five times as many questions. As noted before, the foreman has the requisite knowledge

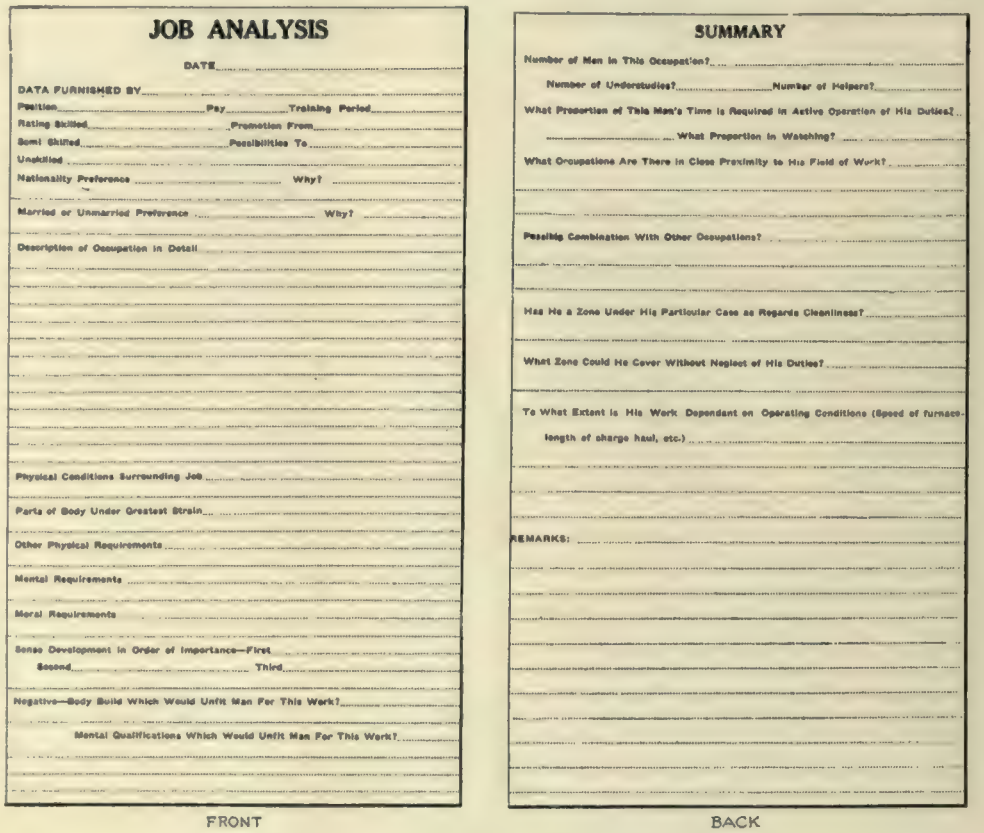

JOB ANALYSIS
DATE
DATA FURNISHED BY
Position
Pay
Training Period
Rating Skilled
Promotion From
Semi Skilled
Possibilities To
Unskilled
Nationality Preference
Why?
Married or Unmarried Preference
Why?
Description of Occupation in Detail
Physical Conditions Surrounding Job
Parts of Body Under Greatest Strain
Other Physical Requirements
Mental Requirements
Moral Requirements
Sense Development in Order of Importance—First
Second
Third
Negative—Body Build Which Would Unfit Man For This Work?
Mental Qualifications Which Would Unfit Man For This Work?
FRONT
SUMMARY
Number of Men in This Occupation?
Number of Understudies?
Number of Helpers?
What Proportion of This Man's Time is Required in Active Operation of His Duties?
What Proportion in Watching?
What Occupations Are There in Close Proximity to His Field of Work?
Possible Combination With Other Occupations?
Has He a Zone Under His Particular Care as Regards Cleanliness?
What Zone Could He Cover Without Neglect of His Duties?
To What Extent is His Work Dependant on Operating Conditions (Speed of furnace-length of charge haul, etc.)
REMARKS:
BACK

FIG. 2 A SECOND TYPE OF FORM USED FOR JOB ANALYSIS

stored away. It is only a question of teaching him its proper application.

The writer is familiar with and has himself undertaken psychological analysis and is a great believer in the value of certain systems as used by several of the original authors and exponents, but he feels that the majority of us are not so fortunately endowed as to be able to make these successfully and that we should stay out of deep water. The foreman comes nearer to possessing this knowledge than anyone.

Our object, therefore, should be not to educate the foreman, but to get him to apply the knowledge he already possesses. The questions used are so framed as to lead up to the possibility of saving so that he will discover this for himself. When he once gets the right idea, no power can stop him from rightfully applying it, so that in many cases he will make efficiency and production engineers open their eyes. Hitherto he has been an unknown and an underestimated quantity. Once let the foreman get the proper idea and give him free rein, and we will have operation of a degree of efficiency never dreamed of. But it is essential that his hands are not tied. Let him handle his men.

Applying "Moving Average" Charts to Industry

They Act as "The Flywheel of Industry" in the Control of Production, Stock, and Sales

By A. L. DeLEEUW*

Consulting Engineer

THE flywheel is such a well-known element in machine design, its functions, its manner of action, and its proportions are so well established, that it has ceased to be a problem. And yet when a flywheel must be applied to a new machine, we recognize the necessity of analyzing not so much the flywheel itself as the conditions which call for it. We recognize the fact that, unless we make such an anlysis, we are apt to make the flywheel too small and thus cause it to fail in its duty, or perhaps too large and thereby make the machine unnecessarily expensive. Therefore we have acquired the habit of looking into the conditions which require a flywheel before we attempt to design one. And all this holds true also for various equivalents of a flywheel: the reservoir for waterworks, the accumulator for hydraulic installations, the storage battery, and so on.

The Industrial Flywheel

Now, the industrial plant may also be said to require a flywheel, a figurative flywheel; in fact, it may require several and yet instead of thoroughly analyzing conditions before we attempt to proportion the industrial flywheel, it would seem that in the majority of cases we either completely neglect such analysis or, at the best, only attempt it in a perfunctory manner.

A flywheel is a means for storing up energy which has to be given out, at least partially, at a given moment. In order to design it properly, we must know the rate at which the energy is supplied, the rate at which it must be given out, and the minimum amount of energy we wish to retain in the flywheel. Strictly speaking, a flywheel is never absolutely necessary. It is merely a means to economy. If we had a thousand cylinders in a steam engine, all working on the same crankshaft, we should not need a flywheel, but without it we would have an absurd and very uneconomical design. We could get along without a flywheel on a punch press, but we would need enormously wide belts and large pulleys. The simple expedient of putting a flywheel on the steam engine or the punch press simplifies the construction and makes it much more economical.

In what way can it be said that we apply flywheels in industry? The analogy may be drawn as follows: In order to manufacture economically we must manufacture at an even rate, and though we may not be able to reach this ideal, yet we are almost instinctively trying to avoid as much as possible fluctuations in the rate of production. On the other hand, we cannot control the rate at which the product may be called for. Here we have the same conditions as we meet in the punch press. Every revolution of the pulley adds so much energy to the machine. The input of energy proceeds at an even rate. The machine only gives out energy when the punch strikes the work, which is during an exceedingly small part of the cycle. Industrial conditions are exactly the same. All the material and labor used in the shop proceed at a fairly even rate while the product is called for at more or less frequent intervals. Shortly the input is even, the output spasmodic. The arrangement which fits the one combination to the other may be called the industrial flywheel.

The First Step is Its Design

This industrial flywheel takes the form chiefly of stores; raw material, work in process, finished parts, finished complete product, are constantly being produced and are shipped more or less spasmodically. In order to reach the highest possible economy this flywheel should be proportioned so that it will function properly and yet be as small as possible. To accomplish this it is necessary to analyze carefully all the conditions under which the shop works; the demand for product, the cost of the product at various stages of completion, the possibility of increasing or decreasing the amount of labor employed without serious disturbance, etc. The writer believes that this is not done intelligently in a majority of cases, and that much waste, and even failure, results from such lack of careful analysis.

The most common way of analyzing conditions is by means of charts or graphical representations of the facts to be analyzed. As a rule, such charts give the form of a bewildering, broken line, jumping up and down from one extreme to the other, and leaving no single complete impression. The points of this chart are obtained from data at hand, generally from tabulations of such data. Looking at a chart of this nature

* Mr. DeLeeuw has had 30 years of experience in American industry. He was born and educated in Holland, and graduated from the University of Leyden and the Polytechnical School of Delft, coming to this country in 1890. In 1893 he was in charge of small tools and methods for the Warder-Bushnell-Glessner Company. In 1897 he became chief engineer for the Niles Tool Works, after which he held a similar position with the Cincinnati Milling Machine Company, where he was responsible for the design of that firm's later types of machines, for cutter development, the introduction of steam lubrication, and other work. He designed and built this firm's new plant at Oakley, and introduced the system of shop control and wage payment which is still in operation. At a later date, in the capacity of chief engineer of the Singer Manufacturing Company, he became responsible for arranging the uniformity of methods in the different plants of that firm. During the war he was in charge of a contract for the manufacture of the recoiled mechanism of the French 75 millimeter guns. This he carried through to a successful conclusion by the excellence of the machining methods he adopted, using untrained mechanics.

and failing to get a clean-cut impression, we look at the various points of the chart and translate them back into figures. In other words, we take a tabulation, construct a chart out of it, and then, in order to understand the chart, we translate it back into a tabulation. This shows the futility of this kind of chart.

Wishing to obtain a view of the progress of sales for a year, we may plot a chart with the dates on the horizontal line and the sales laid off vertically. The first question is, what shall be our horizontal unit—a day, a week, or a month? At a first glance it would seem that the best possible picture of the progress of sales will be obtained by recording them at very fre-

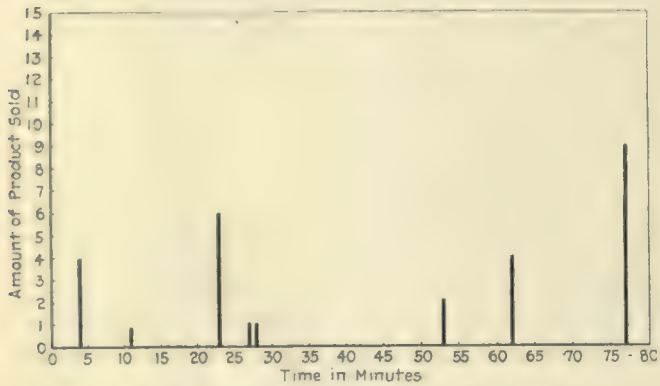


FIG. 1 A CHART OF SALES FROM MINUTE TO MINUTE

quent intervals and plotting these data. This would be true if the object of the chart were merely to furnish a record of what has happened. However, this is not the main object of a chart. It is supposed to furnish a means to visualize these happenings, to show their sequence, their relation to each other, and to some other element, such as time; and to bring into view the law, if there is one, governing the progress of these happenings.

To show that plotting at frequent intervals does not necessarily accomplish this object, we will consider Fig. 1 to be such a chart on which sales are plotted from minute to minute. We will imagine that the chart is made by a machine in which a strip of paper travels at a uniform rate. A pencil, while at rest, draws the base line when no sales are to be recorded. Every minute an operator punches a key, indicating the number of items sold or the number of dollars of the sales made during the past minute. If there is no sale to be recorded the pencil will remain stationary; if a sale was made it will move upward a distance proportional to the sales. In other words, if no sale is to be recorded the key zero is punched; for a sale of one dollar key 1 is punched, etc. The key 1 will cause the pencil to move in a vertical direction one inch; the key 2 will cause it to move two inches, and so on. A chart such as shown in Fig. 1 will be the result.

This chart consists of a number of vertical lines of different lengths, placed at irregular intervals. It gives no impression whatever of the trend of the business, and if one should make such a diagram it would be misleading because some of the widest gaps between vertical lines would simply indicate the period between one business day and the next, whereas the impression one would get would be that there has been a slowing down of the business. Even if this were not the case, the diagram would be of little use because it would be necessary to estimate horizontal distances and make a mental comparison between them and the vertical lines in order to get any idea at all of the progress of the business. We see, then, that frequent plotting of data is not necessarily a good method of charting. On the other hand, it is obvious that too great a time element would make the chart very incomplete.

Fig. 2, curve *PQ*, shows a chart of imaginary sales plotted from week to week. The curve jumps up and down in a perplexing fashion. It shows that the business is spasmodic. Seeing the complete curve, as we see it now, we notice that there is a general increase, but alternated with severe slumps. Looking at the diagram a year after it was made, we obtain a good picture of the progress of the business during the past year, and the diagram proves to be quite enlightening. The best use, however, to which data, tabulations, diagrams, and charts can be put is to guide the manager from day to day in the control of his business, and therefore in order to get the greatest benefit from the chart it must be used before it is completed. It should be made and interpreted from week to week, and not merely at the end of the year.

At the end of the 18th week the manager would be confronted with a rising demand; which becomes stationary, however, at the end of the 19th week. At the end of the 20th week a decided drop is indicated,

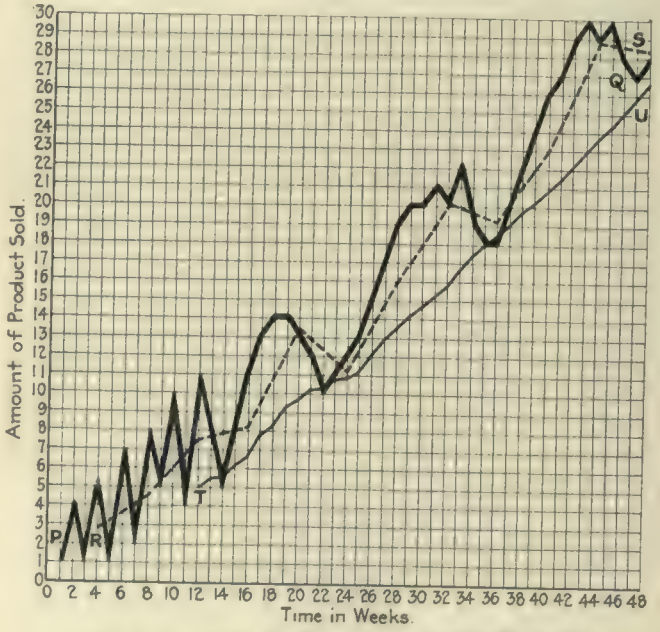


FIG. 2 A CHART OF SALES FROM WEEK TO WEEK

which becomes worse a week later and takes on proportions at the end of the 22nd week which seem to justify him in curtailing production and stopping further purchase of materials. Something similar occurs after the 33rd week. In both cases, however, we find later on that the slump was only temporary, an incident in the progress of the business. Yet the mana-

ger may have discharged labor, missed chances to buy material at favorable prices, and his orders may cause, later on, a shortage of finished product which must be met by an additional effort in the plant. The activities of the plant under such conditions of management would be represented by a diagram with even more violent fluctuations than the one shown here.

The diagram shows clearly that a flywheel is needed. The necessity for some means of ironing out at least part of the unevenness of business is well recognized

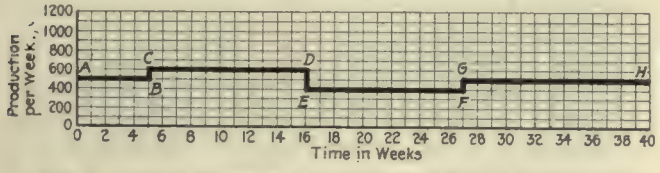


FIG. 3 CHART SHOWING CHANGES IN WEEKLY PRODUCTION

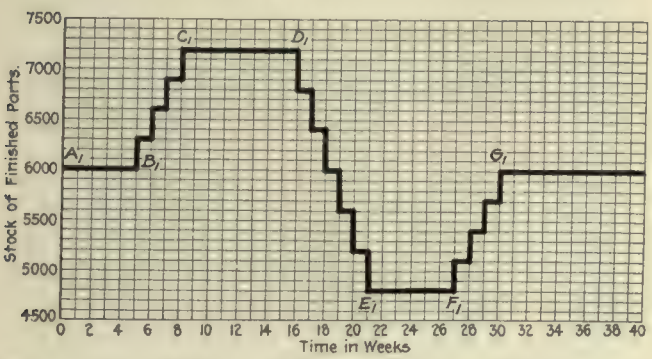


FIG. 4 CHART SHOWING WEEKLY CHANGES IN FINISHED PARTS IN STOCK

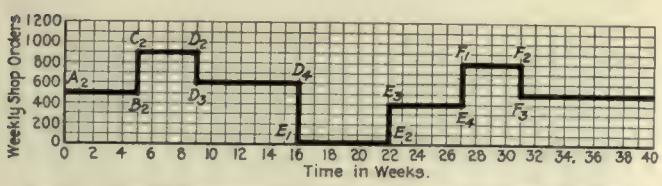


FIG. 5 CHART SHOWING CHANGES IN WEEKLY SHOP ORDERS

and there are various means of taking care of the worst fluctuations. There may be stock in the hands of dealers, or stock at the factory, or finished parts which can be used for assembling the complete product at a moment's notice, and in addition there may be large amounts of work in process and stores or raw material.

It is not so well recognized that it is necessary to study this flywheel in order to make sure that there will be enough stored-up energy to keep the plant going at as even a rate as possible without tying up too much capital unproductively. Fig. 3 represents a set of assumed conditions in a factory, which is supposed to produce 500 units of a certain kind a week. The production is indicated by the line AB. In order to have sufficient stores to take care of any unexpected fluctuations enough parts are kept in stock for 12 weeks' output, amounting in all to 6000 pieces of each part. This is shown in Fig. 4 by the line $A_1 B_1$. These stores will meet a variety of contingencies, such as an unusual demand, a slow-down in manufacture due to labor conditions, lack of raw material, troubles with transportation, accidents, fires, etc. We will assume that the conditions of the business have shown the wisdom of keeping a 12 weeks' supply on hand.

WHY PRODUCTION FLUCTUATES

When the rate of manufacture is increased or reduced the amount of stock must be increased or reduced proportionately. When the rate of manufacture is 500 per week, 6000 pieces of each kind must be kept in stock. The moment this rate of manufacture is increased to 600 per week a stock of 7200 becomes necessary, but a stock of only 6000 being on hand, there is a shortage of 1200. In order to make up for this shortage the orders of the shop should have been increased not merely from 500 to 600, but from 500 to something else, and this something else depends on the time we allow the shop for bringing up the stock from 6000 to 7200.

Suppose that the shop is permitted a period of four weeks to bring the stock to the new level, either up or down; and suppose that at the point B the weekly production is increased from 500 to 600. The manager has increased his orders to that extent because the chart before him seemed to indicate that such an increase is necessary. However, after manufacturing at the rate of 600 per week from C to D, the manager finds that the rise in demand was only apparent and not real, so that he should have kept on manufacturing at the rate of 500 per week. Realizing that he cannot continue to manufacture at a rate in excess of the demand, the manager reduces this rate and brings it down to 400 per week, at which rate he continues to manufacture from E to F. The period of time from E to F is the same as from C to D, and the production is as much below what it should be as the production between C and D was above the proper amount, so that, when we have reached the point F, the same amount has been manufactured as if the production had continued all the time at a rate of 500 a week. As a consequence the manager changes his orders again to 500 per week and continues at this rate, beginning at G. All these changes were necessitated by the fact that the manager misinterpreted the chart at the point B. Without this misinterpretation the diagram of Fig. 3 would have been a straight line.

THE EFFECT ON STOCK OF FINISHED PARTS

Fig. 4 shows the effect which the change in production orders has on the condition of stock. Between A_1 and B_1 the required stock was 6000 and this amount was on hand. The increase of production orders from 500 to 600 per week calls now for an amount of stock of 7200, an increase of 1200; and this increase has to be provided in four weeks, so that the production per week must be $600 + 300 = 900$. At the point C_1 the proper amount of stock has been collected and there is no further change until the point D_1 is reached. At this point the weekly requirements change from 600 to 400, so that the amount of stock required is only 4800. There is, therefore, a surplus of 2400. This

must be absorbed in four weeks, which means that we must draw from stock 600 per week. However, the demand is only 400 per week, so that we do not need to manufacture at all and are not even able to reduce the stock to the proper amount inside of four weeks. As a matter of fact, it will take six weeks before we reach the new level. This happens at E_1. This new level of 4800 continues to F_1. At this point orders are increased from 400 to 500 per week and in order to reach the new level of stock, namely, 6000, inside of four weeks, we must manufacture at the rate of 800 a week until we reach the proper level at G_1.

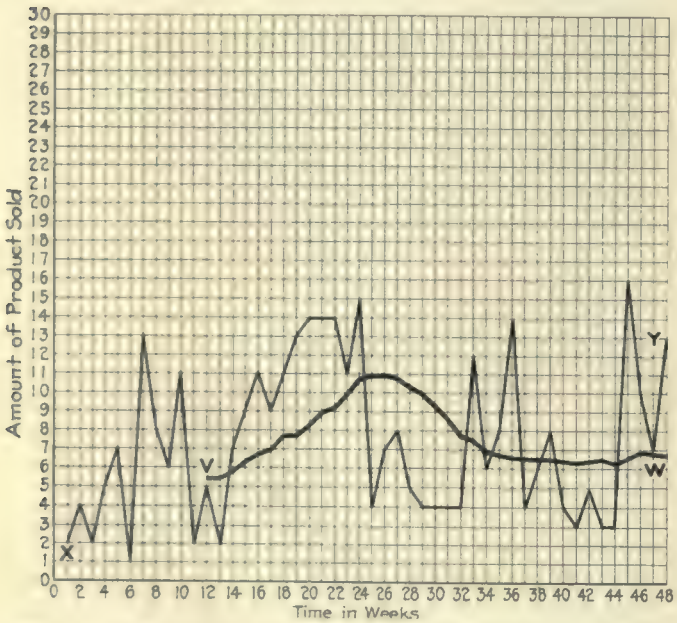


FIG. 6 A COMPARISON OF SALES RECORDS PLOTTED ON A WEEK TO WEEK BASIS (CURVE X Y) AND ON A 12 WEEKS' "MOVING AVERAGE" BASIS (CURVE V W)

Worse than the fluctuation in manufacturing orders or in stock is that of the production orders which must be issued. Fig. 5 shows a diagram of the fluctuation of these orders. At A_2 the production orders amount to 500 per week up to B_2, when they increase to 900 per week. This new order is in effect from C_2 to B_2, a period of four weeks, when it is reduced to 600 per week at B_3 and this new amount remains in effect to B_4. At that point all production is stopped because the 2400 surplus has to be absorbed at the rate of 400 per week. This stoppage of orders starts at E_1 and continues for six weeks to E_2, when it is changed once more to 400 per week at E_3 and continues to E_4. Here, again, the order must be changed to 800 per week at F_1, continued at this rate for four weeks to F_2, when once more a change is made to 500 per week at F_3 and continued at this rate. We see, then, that the production orders fluctuate between 900 per week and zero, and all this merely because of a single error of judgment in interpreting the chart which indicates the demand. It is very obvious that the flywheel has not been properly designed, or, perhaps, speaking more accurately, that the analysis of conditions which led to the design of the flywheel has been very imperfect.

Much of the irregular nature of the diagram disappears when we plot the same data on four week intervals. We obtain curves RS (Fig. 2). However, there are still such sudden changes as, for instance, between weeks twenty and twenty-four. A change such as is there shown seems to indicate that there is a reversal in the trend of business and justifies the manager in a change of policy. And yet all these violent fluctuations are merely ripples on a wave and the wave itself, the general trend of the business, is upward, as will be seen from curve TU.

In this diagram the amount of the sales is not directly recorded. The first point plotted represents the average for the first 12 weeks, that is, weeks 1—2—3 ———12 inclusive. The next point plotted above 13 is again the average of 12 weeks, but this time of the weeks 2—3—4———13. The next point gives the average for the weeks 3—4—5———14, etc. If the manager had been confronted with such a diagram he would not have interrupted production or stopped the purchase of material at the end of the 22nd week, for this diagram shows that there is a consistent increase in sales with minor fluctuations only. If there is a persistent fluctuation in direction, either upward or downward, the manager is justified in taking some action.

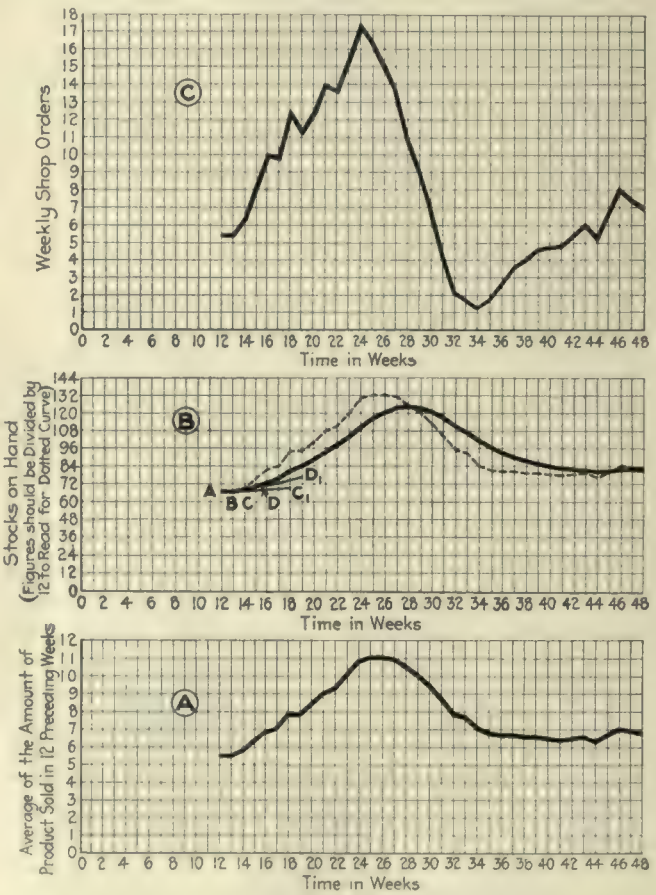

Weekly Shop Orders
Time in Weeks
Stocks on Hand (Figures should be Divided by 12 to Read for Dotted Curve)
A
B C D C1 D1
Average of the Amount of Product Sold in 12 Preceding Weeks

FIG. 7 HOW THE "MOVING AVERAGE" CURVE IS APPLIED TO THE CONTROL OF PRODUCTION, FINISHED STOCK PARTS, AND SHOP ORDERS

Fig. 6 shows such a diagram in which XY is the mere record of sales from week to week, whereas VW is the record of the same business plotted on a 12 weeks' aver-

age. It shows that the business at first increased, was stationary for a short time, then decreased and became stationary again on a lower level.

The diagram *VW* of Fig. 6 is repeated in Fig. 7-A, and immediately above it a corresponding diagram is drawn showing how the stores would fluctuate if the same rules were followed as were mentioned before—namely, that there should always be an amount of stock equal to a 12 weeks' supply and that an attempt should be made to correct discrepancies inside of four weeks. In this diagram (Fig. 7-B) the dotted line represents the progress of sales and the full line the progress of stock. The manner in which this latter curve is obtained is as follows: the vertical scale is the same as in Fig. 7-A, but, for the purpose of indicating the progress of stock, each unit represents twelve times as much as a unit of the vertical scale in Fig. 7-A. At the point *A* we are supposed to have an amount of stock of 66, which is equal to twelve times the sales as shown in Fig. 7-A. At the point *B* no change was made because the sales were the same as at point *A*. The point *C* was obtained by drawing a line from *B* to B_1. This point C_1 represents the amount of stock we should have had at the point *C*. It is, however, four weeks further forward. The point *D* is obtained by drawing the line CD_1. This point D_1 represents again the amount of stock we should have had at *D*, but four weeks further forward. We notice that the curve for stock is generally below the curve of sales as long as the sales are increasing, and is generally above this curve when the sales are decreasing. Our curve, then, shows the action of a flywheel, that is, it takes up energy under light load and gives it out under heavy load. This curve of Fig. 7-B appears to be very satisfactory be-

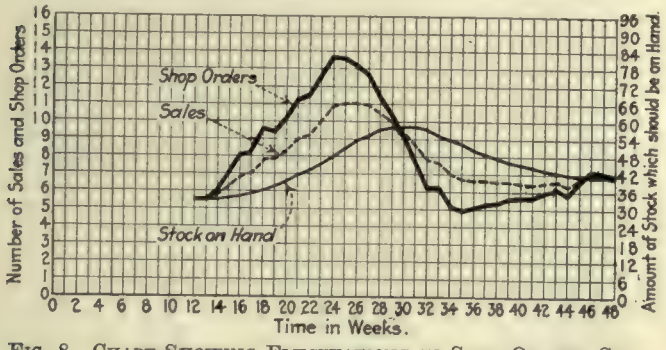


FIG. 8 CHART SHOWING FLUCTUATIONS IN SHOP ORDERS, SALES AND STOCK ON HAND WHEN PLOTTED ON A "MOVING AVERAGE" BASIS

cause the stock on hand is always in close correspondence to the sales.

The curve of Fig. 7-C is developed in the same way in which the diagram for Fig. 5 was developed. It shows the weekly orders which should be issued to satisfy the apparent demand as well as the necessity of increasing or decreasing the stock and making up this difference in four weeks. This diagram shows such wide variations in production for relatively slight variations in sales that we should study conditions further. The reason for such sharp peaks and depressions is that the stock to be kept on hand is many times the amount of sales per week—twelve times, in fact—and because this large increase or decrease must be taken care of in the short period of four weeks. If the stock on hand were only sufficient for four weeks' supply and it were permissible to make up discrepancies in 12 weeks, the diagram would take an entirely different form. Such a diagram of stock on hand and weekly production orders is drawn in Fig. 8 on the

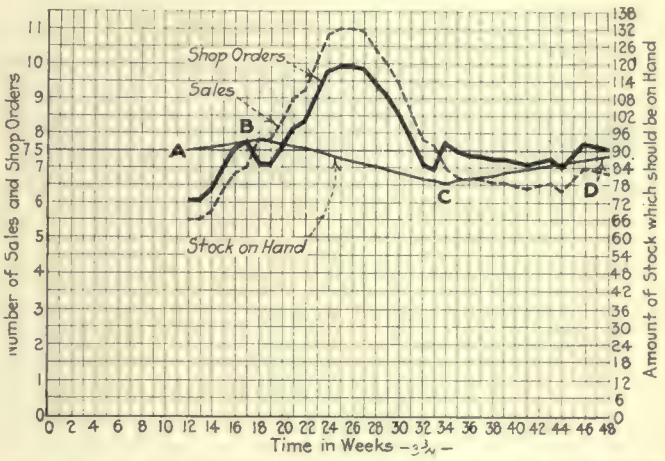


FIG. 9 CHART SHOWING FLYWHEEL EFFECT OF PRODUCTION ORDERS AND STOCK

basis of six weeks' supply and six weeks' time for correcting discrepancies.

The extreme fluctuations of Fig. 7 are not found in this diagram. Whereas in Fig. 7 production orders changed from 160 as a minimum to 1760 as a maximum, when the sales changed from 550 to 1100, the diagram of Fig. 8 shows a fluctuation of 490 as a minimum to 1360 as a maximum for the same fluctuations of sales. Even this diagram, however, is not satisfactory from the viewpoint of the factory. We have established a flywheel to take care of sales by means of stock, but in so doing we have caused very heavy fluctuations in the shop activities.

We might have kept the production orders constant and have drawn from stock when sales were heavy, while delivering to stock when sales were light; but unless we know with certainty beforehand what will happen, there is more than an even chance that either the stock will be entirely exhausted or else mount to such proportions that we must make a change in production. This system of keeping the influx constant is satisfactory when the activities go through a cycle which repeats itself—such, for instance, as the activity of a punch press where the same conditions recur for every stroke. In a business which, in the nature of things, cannot be predicted with any degree of certainty, we must follow a different method. It is desirable to change the production orders as little as possible, yet they must be changed to meet the conditions of sales. We canot continue on light manufacture when sales are heavy, or vice versa.

Fig. 9 shows again the diagram of sales, indicated this time by a dotted line. A horizontal line indicates the amount of stock which is expected to be necessary. This expectation is based on a guess, and the guess, again, is based on the knowledge of what happened the

previous year. As the diagram shows it, the guess is that there will be an average sale of 750 per week and that, therefore, a stock of 9000 will be needed. (It should be noted that the figures on the left side of the diagram are for sales and production orders, while those at the right are twelve times as much and are intended for the diagram of stocks on hand.) When sales are lower than the estimated amount the production order will be raised above what is required to meet the sales. In this diagram the increase is shown as being 10 per cent. The first sale recorded is 550 and the first production order is for 605. As a consequence of this discrepancy between sales and production the stock increases. The progress of the stock is shown by the line *ABCD*.

How Fluctuations in Production Are Reduced

When the sales become more than the estimated amount of 750, the reverse process is followed; that is, the production order will be 10 per cent less than the sales, and the stock will gradually diminish. However, as the stock is very large as compared to the sales for one week, the addition of 10 per cent does not modify the proportion between the actual and the desired amount of stock to any great extent. The diagram shows that whereas sales fluctuate between 550 and 1100, the production orders fluctuate between 605 and 990, thus showing that this method would reduce rather than increase the unavoidable fluctuations. It is understood that 10 per cent is taken here merely for illustration and that any other percentage may be chosen, according to circumstances. For that matter, any other arrangement which irons out the excessive fluctuations in production may be chosen, provided the amount of stock does not go above or below the allowable limit.

This guess of 750 per week may or may not be right. In the diagram shown here there is nothing to prove that it is wrong. However, there might be a case where there is a persistent increase or decrease in the sales which would finally result in there being too little or too much stock. When that occurs a change should be made. Such a change may be made suddenly or it may be extended over a period of time so as to modify as much as possible the evil effects of sudden changes. When we are confronted with such a condition we have to change our flywheel, because we have found that it was either too large or too small.

It should be understood that all of the diagrams shown here are based on arbitrary figures and not on facts. They are intended to show, in the first place, the necessity of a close study of the three elements which should be considered in any manufacturing establishment—namely, production, sales, and stock. They are further intended to show that the stock acts as a flywheel, but that unless the proper relation is established between stock, sales, and production it may have a disturbing rather than an equalizing effect. They also show that for this purpose no conclusions can be drawn from a chart on which individual sales are plotted, but that a chart must be made which shows the general trend of a business and that this can be done by the system of overlapping periods.

There are many other factors which work together to make the relation between stock, sales, and production either correct or incorrect. We must consider the purposes for which it is kept, the time element allowed for bringing this stock up to the desired level, the possibilities of making changes in production, the possibilities of delaying deliveries of product sold, and, perhaps, a number of other considerations based on the peculiar conditions of the particular industry in question.

Business control 658.5
Efficiency for profit 658.51

The Parallel Line of Control in Business

By FREDERIC H. LELAND
Leland, Knowlton and Hanks

THE use of the parallel line of control in business is becoming more and more valuable each year as the successful operation of business becomes increasingly complex. There are two scales of parallel lines of business control: a first, or major scale of control, which shows correctly the amount of money involved in the principal activities of a business according to a logical grouping of its affairs; and a second, or minor scale, which shows the money involved in greater detail than is shown on the major scale. The major scale deals with the group facts of a business in terms of the total amount of money involved with regard to those group facts which are necessary for the use of executives in their general direction of affairs. The minor scale is prepared for the various department chiefs who are responsible for the detail operations of the business. The minor scale shows the money facts in detail, which run to the amounts of the group totals in the major scale.

Major and Minor Scales

Both scales show the trend of business, and the amount of money involved in each of its principal activities. The amounts are plotted on the major scale monthly and on the minor scale weekly.

The minor scale is plotted weekly in order to call the attention of department heads to any discrepancy more often than the facts on the major scale come to the attention of the executive or to whom the department chiefs report. Very often department chiefs are able to direct the affairs of the departments under their control in such a way that while certain discrepancies may appear on their weekly minor scales, they may take such prompt action that by the end of the month, when the major scale points are plotted, matters have so far improved that there is scarcely any indication on the major scale that discrepancies existed on the minor scale, and when the major scale comes to the attention of the chief executive it shows that the heads of departments have made good.

The control lines on both scales are reduced to chart form for easy reading, as shown by Fig. 1. For con-

venience, money values are shown vertically, and the dates against which the money values apply are shown horizontally. There is one sheet of cross-section paper for the major scales, and one or more sheets for the minor scales, depending upon the number of heads of departments who have occasion to use the minor scales, one sheet being allotted to each department head.

The essential lines in the major scale of any business are: *A*, Plant; *B*, Inventories; *C*, Revenue; and *D*, Costs and Expenses.

In a manufacturing business there is a fifth important line, namely, "Yield of Production," if and when

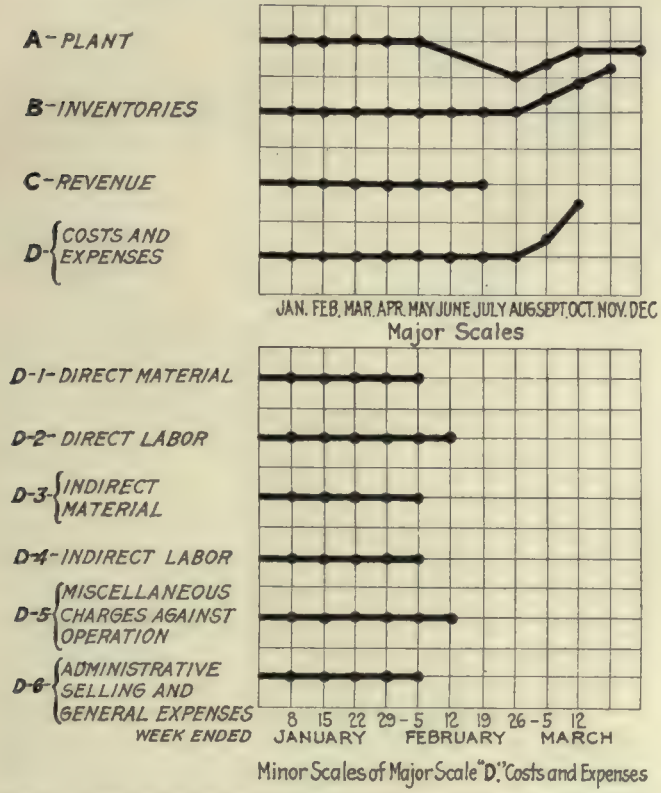


FIG. 1 CHART SHOWING MAJOR AND MINOR LINES OF CONTROL

sold, at the net selling value of the merchandise produced, less cash discount and allowances, if any. The writer pleases to term this yield on production "Potential Revenue." The potential revenue line is logically inserted in the scale between "Plant" and "Inventories," and is a peculiarly valuable line during the present time of business revival. It measures the profit or loss of any plant on its current production every month, if and when sold at a later time and regardless of the quantity of the production actually sold during the same month in which it is produced. Moreover, the "Potential Revenue" line is an essential in the major scale for any manufacturing business dealing in a seasonable product, as it measures the potential profit or loss on production during the months when inventories are accumulating for sale at a later time. The writer has found that a considerable number of plants operate at a lower potential profit than they realize, and at a lower net profit than is at all necessary for the prices obtained for the goods.

The essential subdivisions of a company's statistics as plotted on the minor scales for most businesses are the following:

Major Scale—"Plant"

Minor Scale Subdivisions of Plant:

1. Land
2. Buildings
3. Machinery
4. Equipment

Major Scale—"Inventories"

Inventories are shown in the minor scale according to location as:

1. Stores No. 1
2. Stores No. 2, etc.

or, in some kinds of business, according to the kinds of items that make up the inventories as:

1. Castings
2. Steel
3. Miscellaneous Stores, etc.

Major Scales "Revenue"

Revenues are shown in the minor scale according to the territories that yield revenue as:

1. Revenue derived from Providence
2. Revenue from New York, etc.

The territorial division of revenue is more often applied in merchandising than in a manufacturing business. In the manufacturing business, and sometimes in the merchandising business, the subdivisions of the revenue line are made more often according to classes of goods manufactured.

MAJOR SCALE—"COSTS AND EXPENSES"

The line of costs and expenses is affected by more complicated conditions than any of the other lines of control in a manufacturing business, and requires a more detailed analysis in the minor scale than the other lines. The divisions of "Costs and Expenses" lines in the minor scale are properly the following:

1. Direct material
2. Direct labor
3. Indirect material
4. Indirect labor
5. Miscellaneous charges against operation
6. Administrative, selling, and general expenses

In a well controlled business all of the lines in both scales are maintained parallel, or nearly so, and when any one line persists in moving up or down with regard to any other line, that is the signal for investigation and usually also for action which will straighten the offending line or bring the other lines to conform to its general direction. The necessity for this is readily seen and will be appreciated by every business executive who knows, for example, that when business continues to increase and the line of revenue ascends, then, if the revenue line persists in rising for a considerable number of months or seasons, plant expenditures for extension must be made or the limitations of the plant will eventually pull down the revenue line. It is, therefore, necessary that the plant line be kept approximately parallel to the revenue line after allowing for any lag behind the revenue line that may occur in the plant line due to such lapse of time as may be required to

start plant extension sufficient to support the persistently increased revenue line requirements. Time, of course, must be allowed to determine whether increases of revenues are to be sustained increases, or whether they are merely temporary, in which latter case it might not be expedient to increase plant investments. If, however, the revenue line persists in rising and holding a higher level, then the plant line must be brought up to a position parallel to the revenue line.

The plant line in a new industry may ascend for a time in its relation to the revenue line, but eventually the two must be parallel, and if they are not, one or more of three conclusions are certain: Either the plant is too expensive for the business; sales activities are not yielding sufficiently productive results; or the business is impossible of success on the scale planned.

How the Major Scale is Used

A. Plant. Referring to the diagram of the major scale it will be noted that from the month of May on, line "A," with relation to constant inventories, revenues, costs, and expenses, begins to sag. Such a condition of the plant account plainly shows that the plant and equipment of the business are not being renewed as they wear out, and it is a condition which, if not corrected, will likely have the detrimental result of causing a rising tendency in the line of costs and expenses, if, indeed, it does not cause the revenue line to drop. This last, of course, would be equally unfortunate and will be liable to occur unless such action is taken as will cause the plant line to be brought back to its proper parallel relationship with its fellows, as was the case during September and October.

B Inventories. In August the line of inventory values moved up; in September it moved up further, with no change in the revenue line. If the product was a seasonal one, the sale of which will increase during the following months of November, December, and January, the movement of the inventory line upward may have been, and probably was, logical and necessary for that business. If, on the other hand, the product was not a seasonal one, or if the revenue bearing season was well advanced, then the upward trend of the inventories line very likely indicates overproduction, which in turn means an unnecessarily large investment of money in inventories, or may indicate an error in the book values of inventories which requires to be investigated. A book value error in inventories usually has the effect of inflation, and in any event makes an incorrect and misleading financial statement which is unfortunate for any business. This condition of inflated book values of inventories is apt to prevail if the line of costs and expenses does not descend in proper proportion as the inventory line ascends.

C. Revenue. This is an important line, as by it the others are regulated and in many kinds of business should be moved with it, particularly the lines of plant and inventory. With a descending revenue line, costs and expenses line must be made to drop if the success or continuation of a business is to last during a more or less protracted period of reduced or decreasing revenue.

D. Costs and Expenses. The line of costs and expenses is a difficult one to control by reason of the many ramifications of detailed conditions affecting costs and expenses. A dropping costs and expenses line is a good sign if inventories and revenues are constant, but unfortunately revenue is apt to drop and costs and expenses continue on the straight line and even occasionally increase; a condition largely due at the present time to the lower unit production per dollar of expenditures in most businesses. On the other hand the continued straight line of costs and expenses may be due to the fact that the amount of expenditure in costs and expenses is at the minimum. This, however, should be verified in order to avoid a continuation of unnecessary costs and expenses, which, without the use of the costs and expenses line of control, might go on indefinitely without being noticed.

How the Minor Scale is Used

D-1 Direct Material. Referring to the diagram of the minor scale the line of direct material should fluctuate with regard to the major scale total line "D" in accordance with the variation of the market price of raw and finished materials purchased, and when not so fluctuating it indicates the need for investigating both the quantity and the quality of materials used.

D-2 Direct Labor. This is an important line in the minor scale and has steadily increased in most businesses for the past several years, only recently showing any tendency to resume a normal position in its relation to other cost factors. Every executive in charge of operations understands the use of the labor line in the minor scale of costs and expenses.

D-3 Indirect Material. The line of indirect material offers a safeguard against the extravagant use of indirect expense materials about a plant in order to maintain the desired standard of upkeep and affords control over all expenditures of indirect materials.

D-4 Indirect Labor. This line is analogous to indirect materials and is used in similar fashion.

D-5 Miscellaneous Charges Against Operation. These include depreciation, insurance, taxes, salaries of operating executives that are usually paid from an administrative office, and any other items charged by an administrative office against the operating departments of a business.

D-6 Administration, Selling, and General Expenses. This is the final line in the analysis of the cost and expenses of a business and is placed in the bottom position in the group of principal factors of costs and expenses to conform to the usual position of those items as shown on the profit and loss statement of a manufacturing company in its usual form, before net earnings from operations.

In some instances it is useful to separate administrative and selling expenses and show a line on the minor scale for each of the following items:

Administrative Salaries and Expense
Administrative, Clerical Hire, and Office Expense
Salesmen's Salaries and Expenses
Advertising
Sales Office, Clerical Hire, and Expense

The Value of the Trade Test in Industry

By RUSSELL J. WALDO*

Formerly with The Studebaker Corporation of America

THE old haphazard way of selecting men in industry is fast being replaced nowadays by more accurate methods, in fact as industrial leaders advance they are demanding more accurate and exact methods in every branch of their organizations. Many people, of course, will claim that the knack of picking out men can not be defined with mathematical accuracy; and while this is true, yet there are certain definite standards which if closely followed will enable anyone to select men with far greater accuracy than he could ever expect with the hit or miss methods formerly in vogue.

The leading universities of this country have been conducting tests and experiments upon their students for many years now with a view to determining what class of work the student could best do and in what class of work his natural abilities would be of greatest service. These tests have made clear the fundamental considerations which control student and worker alike and have disclosed many helpful points which any man in charge of hiring workers will find of great value and within his ability to use even though he may not have graduated from a college or even a high school.

The present article does not propose to treat the subject exhaustively or to tell others what they shall use, but is merely intended to show parts of typical trade tests used by the writer with unusual success. His experience has proved to him that there are beyond doubt certain fundamental truths uncovered by psychological research which if directly interwoven with industrial pursuits will produce extraordinary results.

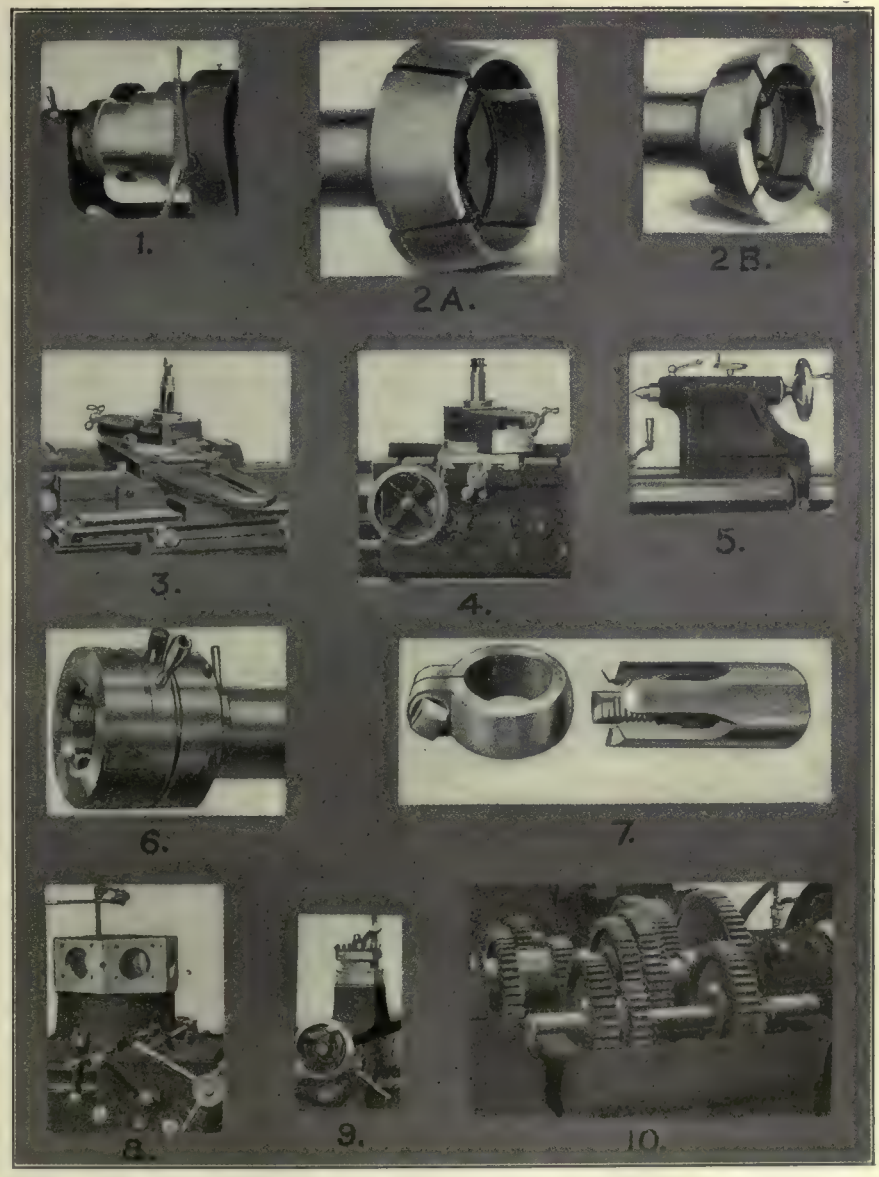


FIG. 1 A TRADE TEST USED IN SELECTING GENERAL MACHINISTS

In using this picture test questions of the following type are asked: How many changes of speed can be obtained for the main camshaft by change of gears? How are feed tools removed? What is the first thing to be considered in setting up a Gridley Automatic Screw Machine? What must be considered in laying out tools for a job? Is the threading spindle operated from the turret?

Up to a comparatively short time ago no definite standards were available by which men could be selected for employment in the wide variety of tasks to be filled in modern industry. This lack of definite standards was naturally a source of loss, and when it began to be proved that it was a source of loss, demand was made for more accurate methods than those formerly in use, when the first applicant was usually placed in the first opening that happened to occur with little or no thought of what he could do.

Numerous methods for the selection of men have

* Mr. Waldo spent nine years in the shop fitting himself for employment work. During the war he was examiner in charge of placement for the Stenotype Company. In 1920 he became assistant employment manager for the Studebaker Company, where he developed his method of trade tests.

been evolved in recent years, and if as remarkable results are obtained by them in the next five years as have been obtained in the past five, industry can expect to have more capable men in its employ and less changing of workers from one job to another. Among these numerous methods are such forms of tests as direct and indirect questioning, picture tests, missing word tests, and general information tests. These the writer finds are best made out in sets consisting of the following parts:

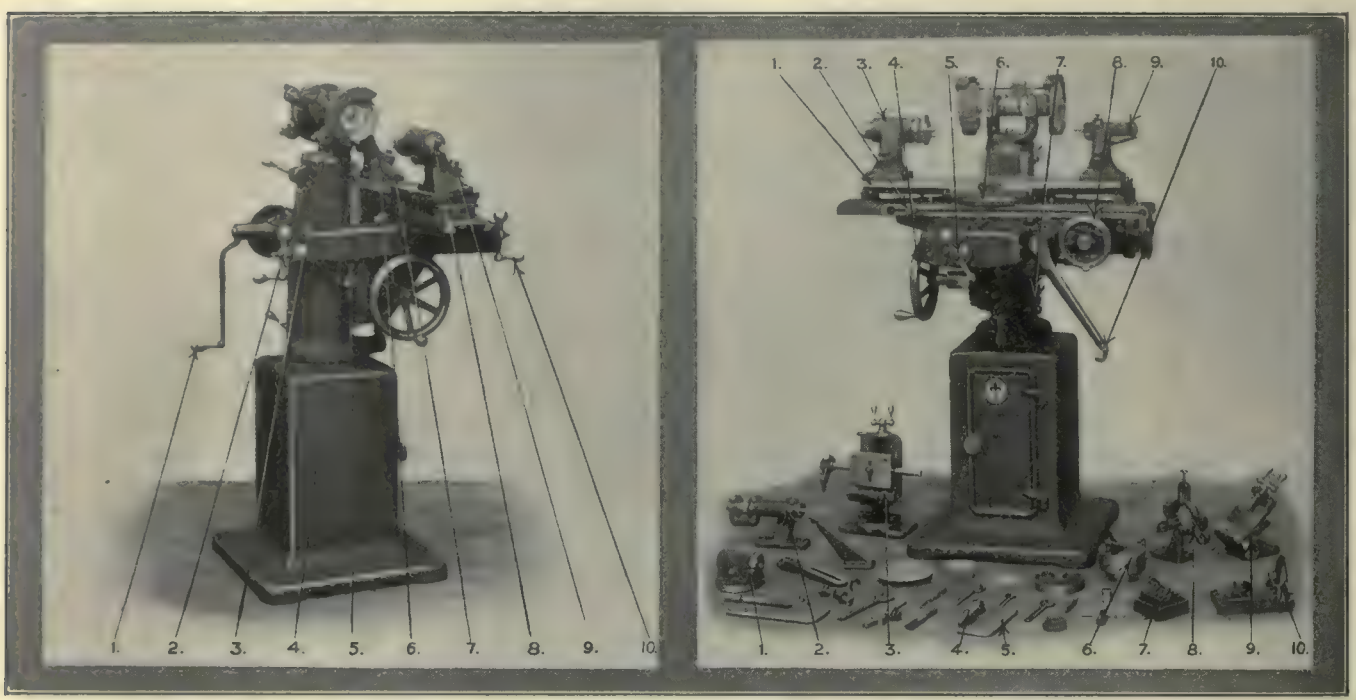
1. Apprentice test
2. Operator's test
3. Highly skilled man
4. Missing word test
5. General data test
6. Machine parts test
7. Special attachments test
8. Individual attachment test
9. Similar machines test
10. Job specification

By a combination of these tests there is nothing regarding a given job which cannot be determined with far greater accuracy than could ever be attained by the old method of questioning.

The trade test is not, as many suppose, a scheme to catch a man. On the contrary it is a well-designed method of questioning which permits a man to show what he can do and what he knows regarding the job for which he asks. It gives each and every man an equal chance and selects the man with the most ability. It plays no favorites and renders the same verdict today concerning one person as it will render a year from today concerning another person with the same ability and under the same conditions. Of course there are certain drawbacks in connection with the trade test, yet these are practically nil in comparison with those of former methods.

While making out the tests to be used it was found advisable to have at hand at all times complete catalogues, part books, operators' handbooks and all other available literature concerning the machine under consideration. Everything that could be thought of was included, and the material that was not wanted or which could be combined or otherwise eliminated was checked off.

It proved most essential to keep the test as small as possible because of the time which would be allotted in giving it. The writer also found it highly advisable and profitable to consult freely with the engineering departments of the makers of the machine as well as with the highly skilled men, the foremen, and the unskilled workers in the plant itself. In this way the rough draft was carefully checked up and each question or part of the test was pronounced essential before it was included. However satisfactory the form seemed as first used, the writer found occasion to make



Front Back

FIG. 2 A TRADE TEST USED IN SELECTING SKILLED MACHINISTS

This figure shows the front and rear views of a Le Blond Tool Grinder and the attachments that are used with it. The numbers have the following significance:

Front: 1. Table 2. Table stop 3. Headstock 4. Vertical movement handwheel 5. Cross feed control 6. Grinder head swivel 7. Knee 8. Table feed 9. Tailstock 10. Table operating crank

Back: 1. Table feed crank 2. Cross feed control 3. Grinder head swivel 4. Table slide 5. Table knee-binder 6. Tailstock 7. Table 8. Headstock 9. Headstock binder 10. Cross feed control

Attachments for Le Blond Grinder: 1. Swivel attachment for universal grinding attachment 2. Internal grinding attachment 3. Universal grinding attachment with V blocks 4. Extension arbor for emery wheel 5. Extension bar for holding tools being ground 6. Universal chucks 7. Dogs 8. Cylindrical grinding attachment 9. Surface grinding attachment 10. Gear cutter grinding attachment

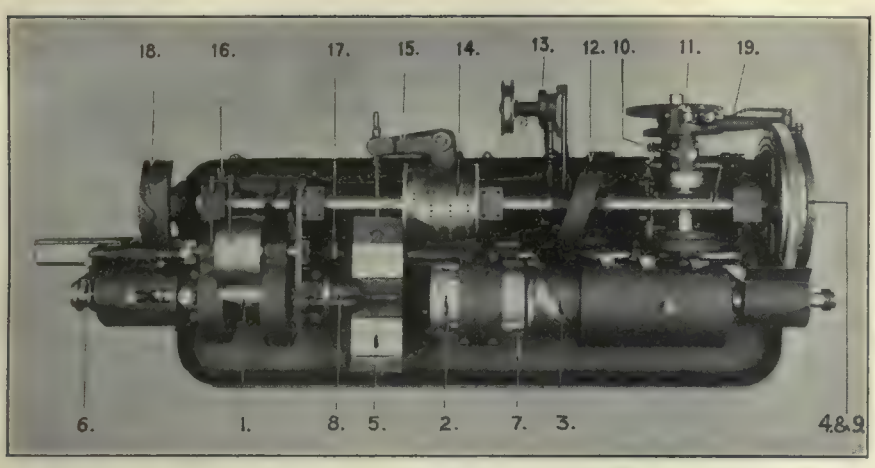


FIG. 3 AN AEROPLANE VIEW OF A CLEVELAND AUTOMATIC SCREW MACHINE

In this figure the numbers have the following significance: 1. Spindle 2. Turret 3. Turret drum 4. Regulating drum 5. Cross slide 6. Stock feed fork 7. Wedge unlocking lever 8. Chuck hood 9. Feed regulating cams 10. Feed bracket 11. Friction roll 12. Stock feed segment 13. Oil pump 14. Cross slide drum 15. Bell crank of cross slide 16. Belt shifter 17. Stock feed rod 18. Chuck operating segment 19. Camshaft.

constant revision and additions to render it more complete. Most of these subsequent changes were the fruit of certain hours spent in the plant keeping in close touch with the foremen and watching the men at their work.

The direct questioning method of determining a man's ability, whether it brings the information out directly or indirectly, is beyond doubt the best. In questioning an applicant his appearance and manner of replying have much to do with the interviewer's final decision. Different forms of memory are also to be considered as some applicants have a memory for names and others for figures.

The test for selecting an apprentice for any department of a plant of course cannot be based upon the applicant's actual experience. The principal things to determine are his natural inclinations and the knowledge he acquired in school which would be of value to him. Promptness in making answers to mathematical problems and in naming parts of machines and tools used in shops also serve as a basis for determining his qualifications. The questions which the writer found most useful in checking up the beginner in ordinary machine work were those which sought to determine what he knew about machines and decimal equivalents.

In making out questions for the machine operator there were other factors to be brought into consideration. These called for certain definite information regarding the machine and the operation of the various parts, and as a rule such questions were used in connection with the picture tests.

A few sample questions used in connection with the Lodge and Shipley test for operator are given below, and, as will be seen, while they are somewhat simple, yet a man must

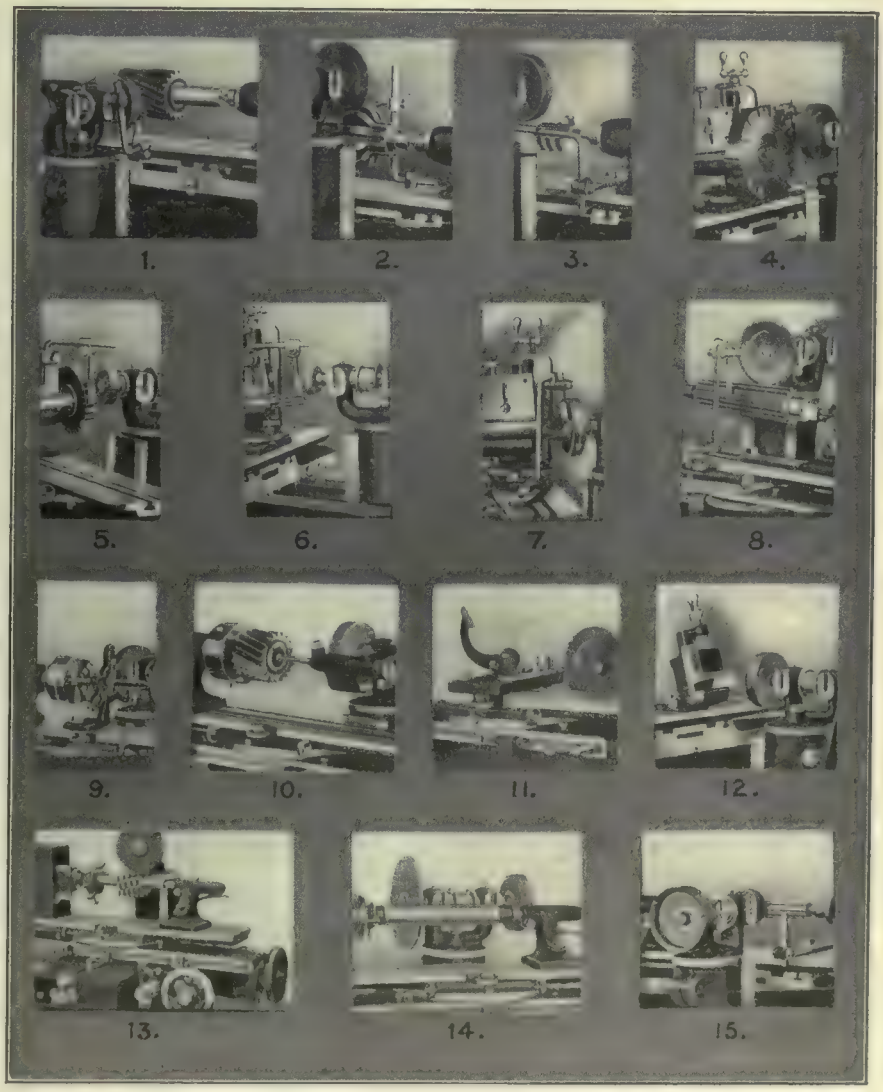


FIG. 4 A TRADE TEST MADE UP OF VIEWS SHOWING PARTS IN ACTUAL USE

This figure shows 15 operations on a Le Blond Grinder: 1. Grinding teeth of spiral milling cutter 2. Grinding a formed milling cutter 3. Grinding a circular formed tool 4. Grinding side of inserted tooth milling cutter 5. Grinding side teeth of side milling cutter 6. Grinding end teeth of end mill 7. Grinding a four-lipped drill 8. Grinding faces of taper reamer teeth 9. Grinding point of center 10. Grinding hole in milling cutter 11. Grinding teeth of a gear cutter 12. Grinding a flat formed tool 13. Worm hob grinding attachment 14. Grinding a straight mandrel 15. Grinding hand reamer.

know the machine quite well to answer them correctly.

Q. How are the gears in the apron oiled?
A. From a reservoir in the top of the apron.
Q. How many tools are provided for in the turret?

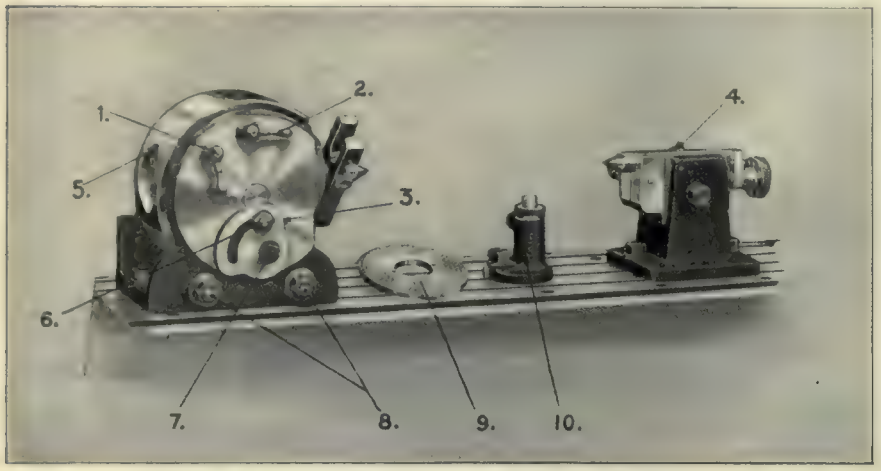


FIG. 5 A SPECIAL ATTACHMENT TRADE TEST

This figure shows a Le Blond Dividing Head. The numbered parts show: 1. Index plunger control for direct indexing 2. Spindle clamp 3. Worm stop screw 4. Verticle center adjustment 5. Rear adjusting nut 6. Quadrant clamp bolt 7. Thrust adjustment for worm 8. Swivel clamps 9. Index plate 10. Adjustable center support

A. Six, one on each face.
Q. How many positions are provided for in the four-way tool block?
A. Eight.
Q. How are the gears in the headstock oiled?
A. Gears are run through a reservoir of oil.
Q. How does the operator know how much oil there is in the headstock?
A. A glass gage is provided.
Q. How are the jaws operated in the quick catch chuck?
A. By the use of a large handwheel which revolves about the body of the chuck.
Q. Of what use are diameter stops?
A. They eliminate much gaging and measuring in obtaining accurate work.

So much for the beginner. With the selection of the highly skilled man a vastly different problem is encountered. For the highly skilled worker various sorts of tests are applied. Every applicant is asked a certain set of questions, but the all around man is asked another supplementary set in addition to undergoing a picture test. If he applies for a position on a certain machine questions are added for the purpose of aiding the interviewer in his determination of the man's ability upon that particular machine.

Fig. 1 shows the picture test used for a general machinist. This illustration is made up of photographs of the parts of a lathe and turret lathe. Questions of the type given in the caption to Fig. 1 were easily made out for use in checking a man's ability and in finding out how readily he could name the parts and their functions.

The writer found that 20 questions were usually sufficient to gain the desired information. However, if some special work on a given machine required a man with special ability, additional questions could be easily worked out to gain that information.

Tests should be organized to determine a man's natural abilities as well as the abilities he has acquired in his work. The questions designed to determine a man's inherited ability require more care than those to determine his acquired ability. A man's inherited ability is his stock in trade, and if the most satisfactory results are to be obtained, he should be directed towards work where his natural abilities will come into play. Acquired abilities are in many cases built up by forced study, and a man will not be so well satisfied in work demanding their exercise.

The picture test arranged with an actual photograph of the machine with arrows pointing to the parts which an efficient employee must know is very satisfactory in determining a man's ability. Such a test is far more reliable than ordinary questioning because, unless the applicant is able to recognize the parts in the picture, it will be quickly shown that he knows little about the machine.

In connection with the trade tests there are many subsidiary points that must be watched if the tests are to be successful. Briefly, some of these are as follows:

The sight is perhaps most important. This is easily checked by watching the applicant as he reads his portion of the test. Color sense should be checked if prompt selections of color are required in the work. Hearing may be checked by speaking in a rather low tone and determining if the applicant plainly hears you. The testing of memory is easily checked by giving a long sentence verbally and asking to have it repeated.

FIG. 6 AN UNASSEMBLED PART TRADE TEST

This figure shows: 1. Face plate 2. Footstock base 3. Footstock clamping lever 4. Work rest base 5. Center rest base 6. Feed-up arm 7. Automatic feed bracket 8. Belt guard grinding wheel head 9. Wheel swivel 10. Traverse handwheel 11. Traverse operating lever 12. Clutch reversing shaft lever.

The writer has found it good practice to use a small sentence to start with, then a longer one, and finally an extremely long one. The same method may be used with numbers, giving lists of numbers of various lengths and having the applicant copy them.

Tests of judgment are not difficult to organize and are of great value. The interviewer, however, should first clearly understand all the factors which control the applicant's judgment and then allow sufficient time for consideration.

All the material that is used to illustrate this outline is copied from my own tests just as they stand today. The originals have so many changes upon them that they have been copied several times. Picture tests have been changed and additions have made them more valuable than they were originally.

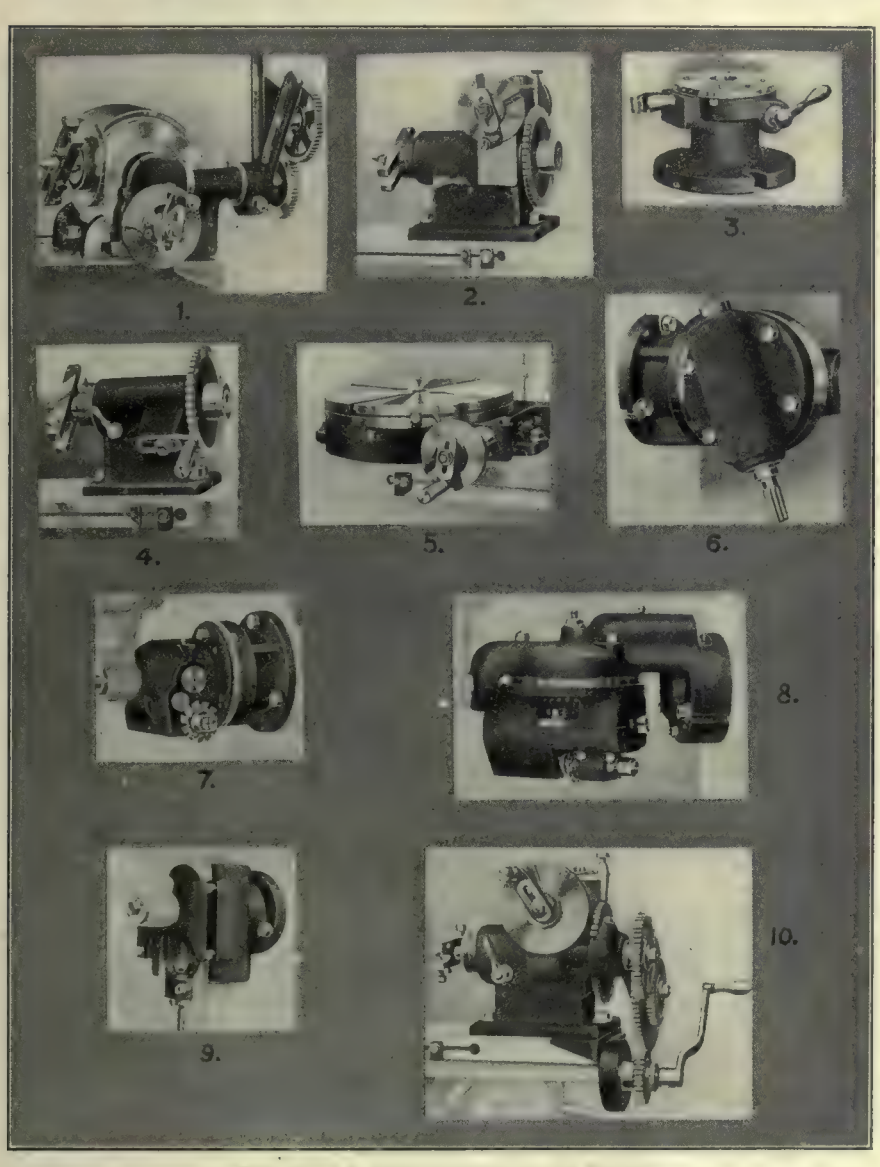


FIG. 7 AN ATTACHMENT TRADE TEST

These views in this figure are taken from a Le Blond milling machine. The numbered parts are: 1. Le Blond Universal Dividing head 2. Gear-cutting head 3. Vertical index head 4. Index centers 5. Circular milling attachment 6. Index centers 7. Rack-cutting attachment 8. Universal speed cutting attachment 9. Slotting attachment 10. Dividing head for cutting spur and spiral gear.

In Fig. 2 the front and rear views of the LeBlond Tool Grinder are shown. The arrows point to various parts which every skilled operator must know, and below the grinder, also indicated by arrows, are the various attachments used upon the machine. The caption gives a key list made out to correspond to the numbered parts upon the photographs. As all parts so indicated are common to operators, it should be an easy and quick problem for the applicant to name them, which he will do if he is as skilled as he claims.

From these keys questions have also been made out, and instead of having the applicant name the parts, these questions have been asked to determine if he knew what a certain part was.

In Fig. 3 a picture test of a different sort is given. There are few operators who have deliberately climbed up where they could look down upon a machine as from an aeroplane. Yet if the operator knows his machine he will be able to name the indicated parts off-hand. The test shown is that of the Cleveland Automatic Screw Machine. There are 20 numbered parts in the test, No. 20 being the oil reservoir, which is not shown in the aeroplane view.

Fig. 4 illustrates another successful test, although of a different sort than those already shown. It is a test made up of parts in actual use. The problem is to have the applicant name as many operations and tools as he can. There are 15 parts showing operations on the LeBlond Grinder Test. The key list is shown with the illustration.

Fig. 5 shows a typical special attachment test. This is of the LeBlond Dividing Head. Again, the key list will be found in the caption to the figure, and in connection with this key list a number of questions pertaining directly to the upkeep and operation of the dividing head were arranged, some of these being as follows:

Q. How is the spindle removed from the head?

A. Remove No. 5. Drop work from engagement with wheel by loosening nut No. 6. Turn worm-shaft to the left. The spindle can then be removed.

Q. What is the function of the stop screw No. 3?

A. It governs the point of mesh between the worm and wheel.

Q. Once set is further adjustment necessary for stop screw No. 3?

A. No. It will always come to the same point of engagement on the axis of the wheel.

Q. Of what use is stop screw No. 3 in replacing worm-shaft?

A. The shaft should be brought to a full stop against it before quadrant bolt is tightened.

Fig. 6 shows the unassembled part test. In this figure illustrations of unassembled parts are arranged for the applicant and if he has the ability he claims to have he will be able to name promptly every part shown. The test shown is that of the Landis Part test.

Fig. 7 shows the attachments test on the LeBlond milling machine. The object of this test is simply to have the applicant name them correctly. The key list is given in the caption, in addition to which the following list of special attachments was made out for use in case the applicant was asked to name all the attachments he could:

Universal Dividing head (plain and with quadrant and change gears)
Special index plates
Gear-cutting head
Vertical index head
Index centers
Circular milling attachment
Vertical milling attachment (for light and heavy milling)
Universal milling attachment
High-speed milling attachment
Rack-cutting attachment
Rack-spacing attachment
Universal spiral cutting attachment
Slotting attachment

In checking up an applicant the description of a machine is of great value to the interviewer. The following is a typical description of the Gridley Multiple Spindle Automatic Screw Machine.

The Gridley Multiple Automatic Screw Machine is designed with four spindles operated by individual gears which are operated by a main gear carried upon the central shaft. This runs the entire length of the machine. It is very rigid in construction, which allows for very coarse and heavy cutting. Speed of the spindles may be changed while the machine is in operation by simply moving the change gear levers. By the use of a double deck tool-holder forming may be done in second position. End working tools may also be used in fourth position by using a special stop which is fastened on the front face of the cross slide. A hole is drilled in this to allow for the forward movement of the slide while the end tool is in operation. Tools are mounted on the four corners of the tool turret.

By a carefully designed mechanism the turning of the spindle carrier starts easy and ends easy, thereby eliminating the jerk often found in starting and stopping the spindle heads.

By the use of internally recessed tool-holders and especially made supports many operations can be performed upon the machine which would be impossible without them.

The missing word test has proved of great value to the writer. In using this test the list of missing words is retained by the interviewer while the sentences in which words have been left out are handed to the applicant. The skilled man should be able to put in the missing words quite rapidly. The missing word test used for the Gridley Multiple Spindle Automatic Screw Machine follows. The words enclosed in parentheses are the omitted words in the original test:

1. The turret tool slide is mounted upon the (spindle carrier).
2. This permits the machine to operate under (heavier) loads and (coarser) feeds.
3. The (speed change) gears are in front of the machine at the right.
4. Stock is fed in the (fourth) position.
5. By using a (double deck) tool-holder heavy forming may be accomplished in second position.
6. The (finished part) is cut off in fourth position.
7. Threading is done in (third) position.
8. The (indexing) mechanism is located on the back side.
9. (Forming) and (cut off) tools are mounted on the cross slides.
10. By using (speed change gear lever) speed may be changed while machine is running.

With each class of tests the writer had a carefully made-out list of similar machines, as experience upon one make of machine is of value to an applicant who is to be placed upon another. Such a list of planers is as follows:

American	Newton
Cincinnati	Niles Bement Pond
Gray	Ohio
Hamilton	Powell
Lynd Farquhar	Whitcomb Blaisdell

Woodward and Powell

As long as organizations continue to push their new employees into the first job that happens to be open, just so long will they continue to increase their production cost. But just as soon as they realize the need of some definite standards by which to select their employees more accurately, they will realize the importance of the trade test. As in the case of other labor-saving devices men will disregard the trade test as long as they feel that they can get along without it and continue to make money by haphazard methods. As soon, however, as results begin to be generally produced by the trade test, executives will turn to it as they did to the employment department.

Just how far the trade test will prove correct in a given situation cannot be exactly stated. It may be said, however, that as soon as a man is assigned to a job it will be evident that the test has been worth a trial. As soon as the man has proved capable at the machine to which he has been assigned, then the total proof of the value of the trade test will be given. Absolute accuracy, of course, cannot be claimed for the trade test, because of the complicated character of the material with which it deals, human in nature. If man could be read as a newspaper, then accuracy could be sincerely predicted of the trade test, but as conditions are, such a claim would be foolish and untrue.

The writer has found that to make satisfactory use of the tests it was necessary to keep continually at their revision. While it would be absurd to expect a perfect trade test, an honest attempt to keep it at least up to date should be made; the results are well worth the effort.

To the novice who claims that the trade test is a burden and not worth the trouble it entails, it might be said here that because it thoroughly organizes the work of questioning it has served its purpose. The old slipshod method never gave the interviewer the information he was seeking, even after he had finished questioning, and it never suggested a doubt that he might possibly be more accurate. Making the interview complete, then, is the trade test's great mission, whereas with the old method after interviewing, say, first a production clerk, then a milling machine set-up man, next a gage maker, the best of interviewers would be almost certain to omit some important question in his

following interview with, say, a machine repairman.

The keen and far-sighted manager of today who is seeking to reduce labor cost to its minimum will find no greater aid in his endeavor than the trade tests which are outlined above, and in making this statement the writer speaks not theoretically but from experience actually gained from their use.

Draftsmen. Training *744(07)*

The Training of Draftsmen

By S. E. FERRY

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FOR some reason many people imagine a draftsman has nothing to do but draw, whereas in reality drawing is in most cases the smallest part of his job. Few people realize this, however, and when applying for a job a considerable number of them bring forward as evidence of their drafting ability the drawings they made in school or copied from boks. A great many of these drawings are works of art, pictorially considered, but they are absolutely worthless from the practical standpoint, and as soon as these amateur draftsmen are questioned as to the way in which the thing designed could or would be made they are entirely lost.

Nearly all textbooks on drawing contain essentials necessary for picture making, but not many of them contain anything else. As a result, graduates of drafting schools very often set up as teachers before they have an opportunity to acquire the practical experience necessary to get the essential information across to the other fellow. They do not realize that a person cannot teach drafting in a practical way unless he has had practical experience himself.

Sooner or later the students of such teachers will find themselves looking over a drawing, if they enter industry, and wondering vaguely what is the reason for this, that, and the other thing. Furthermore, they will wonder why they do not make more rapid progress. Then come worry, pessimism, discouragement, dissatisfaction, floundering, and finally failure. At such a time criticism reacts like a boomerang.

A little reasoning may help us to arrive at some practical conclusions. Starting with the fundamentals, we find that the rules governing the use of decimal fractions, which it has been agreed are essential, are contained in trithmetic. If the draftsman happens to want a root or power of a number with a fractional indice or exponent, he will find logarithms are a great convenience, and, furthermore, their use will assist very materially in mastering the slide rule.

Nearly all the rules in handbooks are now given in algebraic formulas, since they are more concise and convenient; and as it is frequently necessary for the draftsman to transpose terms, his need of algebra will be readily realized.

As soon as it is once thoroughly understood that the basis of mechanical drawing is geometric in nature and its universality is recognized, we see the draftsman's need for geometry.

Frequently draftsmen have occasion to figure out triangles where degrees, minutes, and seconds are specified, and by all means the draftsman should know something of trigonometry.

A knowledge of the action and reaction of forces is likewise essential to the draftsman, since he heals with the use of levers, gears, belts, etc., to transmit power. Hence the draftsman needs a knowledge of that science which is known as mechanics.

A shaft is to be made, a bridge to span a chasm, or a building to be erected. Naturally it must have sufficient strength to withstand the stresses to which it will be subjected. This is another subject with which draftsmen should be familiar, and is treated specifically in strength of materials. Also unless the draftsman knows something about the chemical composition and characteristics of materials, he might specify cast iron, semi-steel, or cast steel castings or even a drop forging where bronze should be used.

A Knowledge of Business Also Necessary

Another very important factor that enters into every design is cost. The draftsman must, therefore, acquire a knowledge of relative costs of materials as well as of their weights and know what sizes can be secured of the various shapes and kinds of materials required.

The draftsman should also know how the various materials can be formed into the desired shape, whether by sawing, casting, forging, molding, machining, or otherwise. For the same reason he should know the principles of forging, rolling, drawing, extruding, stamping, die-casting, spinning, and similar processes.

Often several different kinds and grades of steel are used on a job, and there will be many occasions when the draftsman will need a very specific knowledge of the "how" and "why" of annealing, tempering, and case hardening.

Drawings are sometimes required of machines in the course of assembly in order to get proper adjustments, and unless the draftsman knows something about assembling, which takes in considerable knowledge of shop practice in general, including such matters as lapping, filing, scraping, chipping, etc., he will find himself very much handicapped.

In a great many instances special provision must be made by the draftsman to facilitate the handling and storing of the apparatus after it is finished and waiting to be shipped; for example, the eye bolts in motors and lifting links in transformers, and lifting lugs on various other pieces of machinery. These are a few of the reasons why the draftsman should have a very definite knowledge of the economics of manufacturing methods.

Unless the draftsman also has a knowledge of the tools (both hand and machine) that are available, he will be very apt to design a piece in such a way as to require additional expense for new tools; but if the draftsman has a knowledge of the shop equipment and manufacturing methods he will be able to design parts so they can be made in the most economical way.

All these subjects can be taught very successfully by a combination of reading courses, questions, lectures,

discussions, and excursions combined with classroom instruction and parallel with shop and drafting office experience

Finally, a working knowledge of the systems used in the clerical, purchasing, storekeeping, accounting, sales, patent, and shipping departments, since they are so closely interwoven with the engineering department systems, will assist the draftsman very materially in determining "why," "when," "where," and "what," and arriving at the "how" in numberless cases that frequently come up for disposition.

Management engineering. Education *658(07)*

A New Course in Management Engineering in England

By R. POLIAKOFF

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IN the July number of MANAGEMENT ENGINEERING, Prof. Collins P. Bliss gave the detail of seven courses in management engineering in use in American univerties and technical schools. Similar courses are being introduced abroad. As an example, the Municipal College of Technology in Manchester, which is considered one of the best schools for higher technical education in England, has opened recently a new Department of Industrial Administration which in the words of the college authorities has the following objects:

1. To investigate all problems relating to industrial management and to collect and co-ordinate the information obtained with a view to assisting in the building up of a science of industrial administration.
2. To put all knowledge so gained at the disposal of the business community and in particular to organize classes and lectures for managers, workers, and students.

The subjects to be studied in the department will be as follows:

A. INDUSTRIAL HISTORY
- 1. Medieval Guilds
  - Statute of Apprentices
  - Domestic System
  - Colonial Expansion
- 2. Industrial Revolution
  - Mechanical Inventions and Improvements in Transportation
- 3. Factory Legislation
  - Trade Unions and Employers' Associations
  - Co-Operative Movement
  - Health Insurance
  - Unemployment Insurance

B. LABOR ASPIRATIONS
- 4. Trade Unions
  - Conciliation and Arbitration
  - National Industrial Councils
  - Trade Boards
- 5. State Socialism
  - Guild Socialism
  - Syndicalism
  - Communism and Bolshevism

C. ECONOMICS
- 6. General Principles
  - Production
  - Labor and Machinery
  - Unemployment
  - Exchange
  - Credit and Interest
  - Distribution
- 7. Organization of Industry and Commerce
  - Competition
  - Localization
  - Combinations
  - Company Formation
  - Foreign Trade
- 8. Industrial Finance
  - Gold and Paper Money
  - Inflation
  - Index Numbers
  - Banking
  - Company Funds
  - Foreign Exchange

D. TECHNIQUE OF MANAGEMENT
- 9. Type of Management
  - Departmental
  - Functional
  - Committee
- 10. Employment
  - Selection
  - Education
  - Training
  - Discipline
  - Works Regulations
- 11. Routine
  - Planning
  - Progressing
  - Graphical and Statistical Control
  - Cost Accounting
  - Time and General Offices
- 12. Experimental
  - Processing
  - Rate Fixing
  - Time and Motion Study
  - Fatigue

E. PERSONAL
- 13. Incentives
  - Time, Piece, Premium Plans
  - Sliding Scale
  - Profit-Sharing
  - Co-Partnership
  - Promotion
- 14. Working Conditions
  - Security of Tenure
  - Sick Benefits
  - Pensions
  - Holidays
  - Safety and First Aid
  - Hygiene and Sanitation
  - Welfare, Canteens, etc.
- 15. Interrelations
  - Internal Publicity
  - Personal Contact
  - Community Interests
  - Works' Committees
  - Spheres of Activity
  - Relation to Management
- 16. Education
  - Continuation Education
  - Apprenticeship Schemes
  - General Adult and Vocational Training
- 17. Recreation
  - Cultural
  - Sports
  - Handicrafts

From the above it can be seen that the program is complete, and taking into account the general interest in management engineering which is felt now both in this country and in Europe, one cannot fail to notice that the new Department of the Manchester College has developed a very complete program.

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The Organization of Knitting Mills

Standardizing the Control of Material

By CARLE M. BIGELOW*

Chief Engineer, Cooley and Marvin Company

AFTER an effective type of organization for a knitting mill has been decided on and the matter of plant layout and routing determined, as described in previous articles,[1] we come to the actual establishment of managerial control, and the first step to this end will usually be found to be the consideration of the materials involved. Before materials can be controlled, however, they must be standardized, and the first step in standardization is symbolization. Hence it seems desirable to cover the entire subject of symbolization at this point.

The Purpose of Symbols

The fundamental purpose of symbols is to provide a short, definite nomenclature for each item in an industry, thus avoiding (*a*) errors through varying descriptions; and (*b*) excess clerical time in entering long descriptions on orders, requisitions, etc.

In the knitting industry symbols should usually be applied to:

Yarns	Operations
Miscellaneous materials	Machines
Departments	

The following is part of a set of nemonic symbols established for an underwear mill and illustrates how such symbols are used:

Yarn Symbols. The symbols for yarns are made up of eight parts, which are separated by dashes except between the ply and the count, when a line is used, and after the count where the next symbol is not numerical, in which case the dash is omitted. These parts are:

1. Ply	5. Process
2. Count	6. Color
3. Mechanical process	7. Form
4. Composition	8. Vendor

(A) SYMBOLS OF COMPONENT PARTS

1. Ply (Omitted when yarn is single ply)

Ply number	The number representing the ply.

2. Count

Count number	The number representing the count.

3. Mechanical Process (Omitted except for "Combed")

4. Composition

Worsted	W	Egyptian	E
9A50/50	9A50/50	Peeler	P
50/50	50/50	S/43	S/43
109	b109	Sea Island	SI
272	272	Silk	S

5. Process (Omitted unless specified)

Scrooped	Sd	Oxford	O
Bleached	B	Mercerized	M
Reversed	R	China	C
Gassed	G	Japan Organzine	JO

6. Color (Omitted unless specified)

Natural	Nl	White	We
Pink	Pk	Cream	Cm
Gray	Gy	Silver	Sr

7. Form (Omitted unless specified)

Cops	Cp	Skeins	Sn
Cones	Cn		

8. Vendor (Omitted unless specified)

Wamsutta	Wa

(B) SYMBOLS OF YARNS[2]

1/60 White Worsted	60W-W
1/60 Natural Worsted	60W-Nl
2/8-1/2 Bleached Worsted	2/8-1/2 W-B
1/25-9A-50/50 Natural	25-50/50-Nl
1/30-50/50 White	30-50/50 W
1/10 Carded S/25	10-S/25
1/9 Combed Egyptian	9C-E
1/10 Combed Peeler	10C-P
2/45 Combed Peeler Gray (Cones)	2/45C-P-Gy-Cn
2/100 Combed Sea Island	2/100C-SI
2/20 Combed Peeler Mercerized Gray	2/20C-P-M-Gy
1/20 White Silk	20S-We
750 Yards Embroidery Silk	750ES

Operation Symbols—Yarn

Pick	Pk	Roving 1	R1
Comb	Cb	Roving 3	R3
Ribbon Wind	RW	Spin	Sn

Operation Symbols—Underwear

Operation	*Symbol*	*Operation*	*Symbol*
Wind	Wd	Stitch Neck	SN
Load	L	Merrow	Mw
Loop	Lp	Shoulder Straps	SS
Wash	Wh	1st Shell	Sll
Rinse	R	Button-hole Stay	BHS
Extract	X	Edge Sides	ES
Dry Mast	DM	Edge Armhole	EAH
Cut Neck & Front	CT	5 Thread	5T
Length Cut & Fold	CF	Binding	Bg
Rack Gussets	RG	Patch	Ph
Cut	Ct	Button Hole	BH
Cut Armholes	CAH	Sew Tubes	ST
Overseam Gussets	OG	Press Cuffs	PC
Overedge Cuff	OC	Button	Bn
Shoulder	Sr	Steam	Sm
Seam	S	Cut Cuffs	CC
Hem	Hm	Cut Fashion Sleeves	CFS
Tubing	Tg	Draw Cord Fashion	

* Mr. Bigelow was graduated as Bachelor of Science in chemical engineering from the Rhode Island State College, and during the present year has had conferred upon him the professional degree of mechanical engineer by the same institution. His experience in industry began as an operative in all the departments of cotton manufacturing and dyeing—with the Manville Company. From October, 1912, to June, 1916, he was operative, gang boss, foreman, time-study man, engineer and plant superintendent for the Glenlyon Dye Works. From that time until June, 1918, he was senior engineer for the Cooley & Marvin Company, and on the latter date became the chief engineer of the firm.

[1] See Management Engineering for October, p. 193, and November p. 261.

[2] The table from which these items were selected contains 120 designations and symbols.

DEPARTMENT SYMBOLS

Department	*Symbol*	*Department*	*Symbol*
OFFICE			
Accounting	OA	Cost	OC
Billing	OB	Planning	OP
No. 1 MILL			
Boxing	1B	Stockroom	1S
Packing	1P		
No. 2 MILL			
Miscellaneous	2M	Cutting	2C
Knitting	2K	Seaming	2S
Bleaching	2B	Finishing	2F
No. 3 MILL			
Office	3O	Cutting	3C
Yarn	3Y	Seaming	3S
Knitting	3K	Finishing	3F
Bleaching	3B	Inspecting	3I
No. 5 MILL			
Storage	5S		

MACHINE SYMBOLS—YARNS. The machine symbols are made up of the general symbol of the operation performed on the machine and an abbreviation of the manufacturer's name.[3] Individual machines will be designated by serial numerical suffixes.

Machine	*Manufacturer*	*Symbol*
Picker	Kitson	PkK
Comber	Whitin Machine Co.	CbW
Ribbon	Whitin Machine Co.	RWW
Slubber	Saco Lowell	R2SL
Speeder	Saco Lowell	R4SL
Overedge: Car. Cuff	Merrow	OCM
Shoulder Machine	Wilcox & Gibbs	SrWG
Tubing Machine	Metropolitan	TgMn
Neck Stitcher	Union Special	SNUS
Crossing Machine	Union Special	CsUS
Button Stay: L. Mach.	Union Special	BSUS-L
Bind: Neck Machine	Union Special	BgUS-N
Patch Machine	Rose Label	PhRL
Button-hole Machine	Singer	BHS
Cuff Presser		PC

MACHINE SYMBOLS—UNDERWEAR.[4] In the case of Knitting Machines a numerical symbol will be added to the machine symbol which indicates the size of the head and the cut. Example: Wildman Knitter, 16 head, 8 cut KtW16-8.

Machine	*Manufacturer*	*Symbol*
Skein Winder		SWd
Winder	Payne	WdP
Knitter Rotary	Cotton	KtRCn
Rubber Cover Mill		RC
Looper	Record	LpR
Loader	Palmer Bros.	LP
Extractor	Tolhurst	XT
Spreader	McCreary	Sdm
Cutter	Eastman	CtE
Merrow: Gussets	Merrow	MGM

In the mechanical industries the next step in standardizing materials after symbolizing those materials found in use is to study the use of each, eliminate everything possible, and then determine the maximum and minimum stock requirements for each. This same practice holds in the knitting industry, but with this modification: Due to the wide range of styles, seasonal business, etc., the requirements for yarn (the vast bulk of the material used) constantly vary, thus necessitating a very careful control in order to provide readily the requisite yarn without danger of overstocking.

[3] In this particular list of equipment the reference to maker could be readily omitted. It is shown, however, as in many plants similar machines may be used made by different manufacturers, as:

Card	Saco Lowell	CdSL
Card	Whitin Machine Co.	CdW

[4] This group was selected from a table having 77 items and symbols.

THE CONTROL OF YARN

The following illustrates a method of controlling yarn for an underwear mill. An underwear mill is taken as an example, rather than a hosiery mill, as the former introduces the complication of figuring in terms of the knitted cloth, whereas this step, of course, is eliminated in a hosiery or sweater mill.

(*a*) *Assignment of Production.* In order to provide for an adequate supply of raw materials at all times and at the same time avoid an oversupply, it is necessary to determine definitely the quantity of each material which will be required during each productive period and to secure its delivery a reasonable time before it will be needed.

Methods have been developed by which each customer's order is assigned to a definite productive cycle as soon as it is received, and the probable duplicate business for the same period is determined. Hence by computing the detailed quantities of materials necessary to manufacture goods for these orders, the total amounts required for each cycle and each month can be found.

(*b*) *Determination of Yarn Requirements.* The first step in determining the quantities of yarn needed will be to compute the quantity of knit cloth which will be required. Cloth computation tables show the weight of the body cloth of any number of dozen garments from 1 to 99. About 140 cards are required, one card for each garment weight. The weight of cloth required for each style of goods is obtained weekly from the weekly totals of dozens on recap-sheets by using the computation cards, and are recorded and totaled on the corresponding cloth quota card.

As soon as the first cycle of a month has been closed, totals are made up of all garments taking the same style of cuff, and an estimate is made of the total number of cuffs for the month, assuming that the ratio will be the same during the succeeding cycles. The weights of cloth are computed from these on the comptometer and entered on cloth quota cards.

The second step is to compute the quantities of yarn from these totals from the percentage composition of each kind. For this purpose yarn computation tables have been designed which show the number of pounds of yarn required to make any weight of cloth from 1 to 2000 lb. There are three cards for each percentage in use which show these quantities—the first for every pound from 1 to 100 lb.—the second and third for every 10 lb., from 10 to 1000 lb., and from 1000 to 2000 lb. A total of only about 150 cards will show all necessary quantities from which the weights of yarn required to cover each kind of cloth will be found and recorded and totaled on the yarn quota cards.

Fig. 12 shows a production indicator which sometimes, when the line of product is not too wide, can be used to advantage to figure yarn requirements. In-

spection of the figure will readily disclose the method of operation.

(*c*) *Yarn Schedule Records.* Yarn schedule cards provide a convenient means of showing the yarn schedule clerk the tendency of requirements for coming months and enable him to keep the yarn purchasing agent in touch with the situation. A separate card is kept for each yarn for each delivery month, and the totals from the yarn quota cards are posted to them each week, being recorded in the columns for the corresponding cycles.

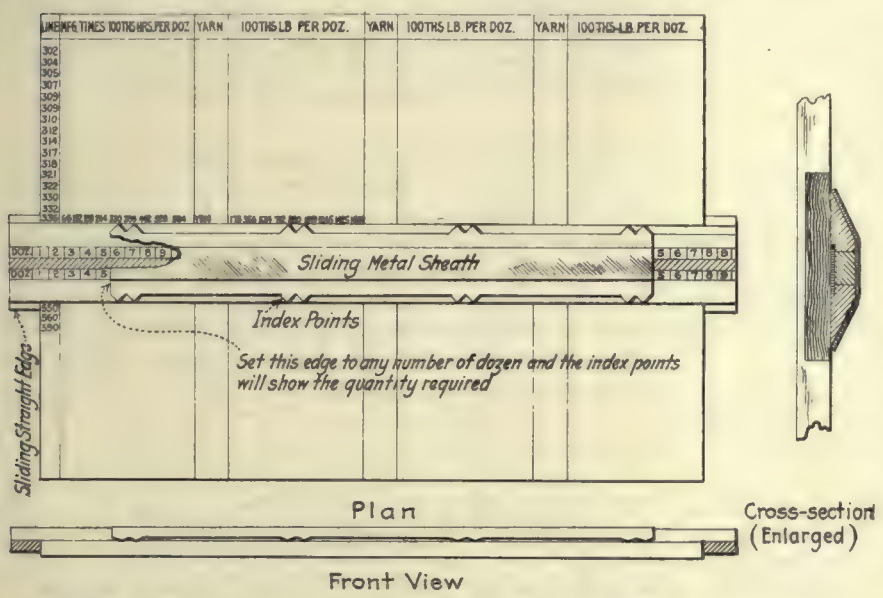

FIG. 12 A PRODUCTION INDICATOR USED FOR COMPUTING YARN REQUIREMENTS

There is also provision for entering the specifications of any orders placed to cover these requirements. These cards replace the present yarn schedule cards which are used for a similar purpose but which do not present the information in sufficiently detailed form. These records assist both the purchasing agent and the production manager as they show at all times the known detailed and total yarn requirements for future months and the extent to which they have been provided for by orders. This information together with the knowledge of the extent to which the productive capacity of the mills was applied makes it possible to place definite orders for necessary yarns for each month and week.

(*d*) *The Yarn Chart.* The yarn chart, Fig. 13, is designed to illustrate graphically the exact condition of yarn requirements. The charts are mounted on boards, a separate chart being used to show, at any time, the conditions for the coming four weeks, and one for each of the next three months.

The chart is laid out on a logarithmic scale which makes it possible to maintain the same proportional accuracy for small quantities as for large ones. Colored pins are inserted in the spaces provided against the various yarns, the locations of the pins indicating the quantities to be shown. A red pin is used to indicate the quantity of a yarn that is required, a green pin for the quantity on order, and a black pin for the quantity on hand.

At the left of the chart is a space where signals may be inserted. A red tack shows a dangerous condition of the supply, a green tack that a rush order had been given to cover a dangerous condition, and the absence of a signal indicates an ample supply.

The information shown is laid out every week by reference to the yarn schedule cards and a perpetual inventory kept in the yarn ledger, and so provides the production manager with a visible and timely warning of any threatened lack of supply.

The monthly amount of many of the miscellaneous raw materials used in garments is small, both in volume and in value, so that the expense of keeping a comparatively large supply of these on hand is small compared with the disturbance which is caused if this supply runs out. For these materials minimum and maximum quantities to be kept on hand are carefully worked out in conference with the production manager and the stock records clerk, taking into consideration, in each case, the maximum monthly requirements together with the condition of the market and the transportation facilities. Table 1 is an example of standardization of miscellaneous materials.

Supplies, such as brushes, pencils, forms, oil, etc., should be standardized in much the same way as miscellaneous materials. Instead of handling supplies entirely in stockrooms, as described later for the other classes, it is advisable to maintain small "limited stores cabinets" in each department. Such a cabinet is illustrated in Fig. 14.

These cabinets are so constructed as to hold exact quantities of each article necessary for an ordinary week. The cabinet is locked and the contents disbursed by the foreman, forelady, or some other reliable individual. Once a week the stores department replenishes the cabinet, making out a material requisition charging the amount replenished (which naturally equals the amount just used) against the department.

TABLE 1. HOSIERY BOXES—STANDARD STOCK LIMIT

Box	Label	Description	Quantity to Be Ordered	Order When Stock Reaches
1		Silk	200	100
1	2	Mercury	200	100
4		Botany	200	100
4	2	Mercury	200	100
4	3	Cashmere	200	100 order no more until new label is made
4		Sanitary	300	150
4		Seconds	200	100
4		Monbro	...	... Order no more.
4		Cachmerino	200	100

In the layout of the stores used in a combined hosiery and underwear mill each section should be symbolized by a letter or letters.

In charge of the stores there should be a storeskeeper who should be a person of accuracy, neatness, and extreme responsibility, and should be required to keep the stock in good condition with a minimum of assistance.

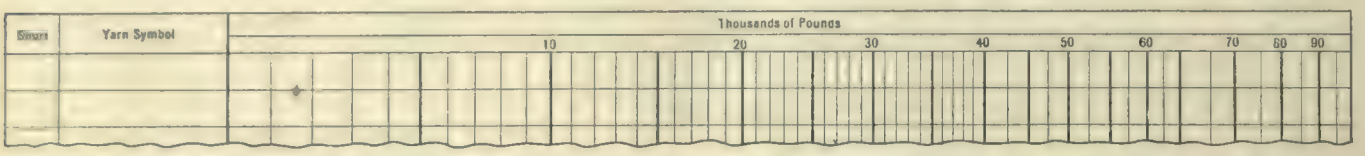

FIG. 13 YARN CHART DESIGNED TO ILLUSTRATE GRAPHICALLY THE EXACT CONDITION OF YARN REQUIREMENTS

All stores are classified into five divisions:

1. Closed stores. All cased and baled goods in their original state.
2. Open stores. All materials and supplies less than an original case or by character requiring location in the miscellaneous stores section. This also includes mechanical supplies.
3. Paper boxes. All paper boxes.
4. Reserve and overflow stock. Such stocks as overflow, as decided by the management, are placed in specially provided sections.
5. Shipping supplies.

Fig. 15 is the form used for the control of closed stores. This is designed in card form, each unit being entered with weight, net weight, and location of the unit, and the record shows a perpetual balance of each lot.

Fig. 16 is the form used to control open stores. This record is designed in card form for a continuous recording, with all necessary information.

The Method of Control. The purchasing department[5] sends to the storeskeeper a copy of each order sent to a vender in which the quantities and the prices are left out. The storeskeeper files these copies in alphabetical order and when goods arrive refers for identification to the order copy, which will be attached to the receipt of order completed.

The left-side platform is reserved for receiving incoming shipments. The bell on this platform connects with the storeroom, and individuals making deliveries are requested to unload their goods on the platform and ring the bell. Thereupon the storeskeeper responds immediately and signs for the delivery. All shipments must be received and signed for by the storeskeeper.

The storeskeeper determines from the order copies whether the goods are to be placed in the stores or sent directly to a department and makes out the store's receipt. If the goods are for immediate departmental use, they are sent to the department with this receipt, but they are not delivered unless the receipt of goods is signed by the department superintendent. The storeskeeper countersigns the receipt, attaches his order copy (provided the shipment is complete) and places it in the "office clearing box" on his desk. If such goods are for open stock the procedure is the same, the storeskeeper signing the receipt, attaching the order copy, and placing them in the office clearing box. The order copy is attached only if the shipment is complete, otherwise the receipt is stamped "Not Completed" and the order copy filed away again after the quantity of shipment is marked on the back of the order copy.

Store Records. Of all stock carried in the storeroom, a store's control record is made out immediately before the stock is put on the shelves; each record must contain full information, referring to location, stock on hand, and maximum and minimum stock, and must also have the Material Ledger account number. For stocks having no stores control record, the maximum and minimum limits are obtained from the purchasing agent, while the number of the Material Ledger account is obtained from the invoice clerk. If the goods have already a stock balance the new shipment is entered in the "Received" column and added to the balance.

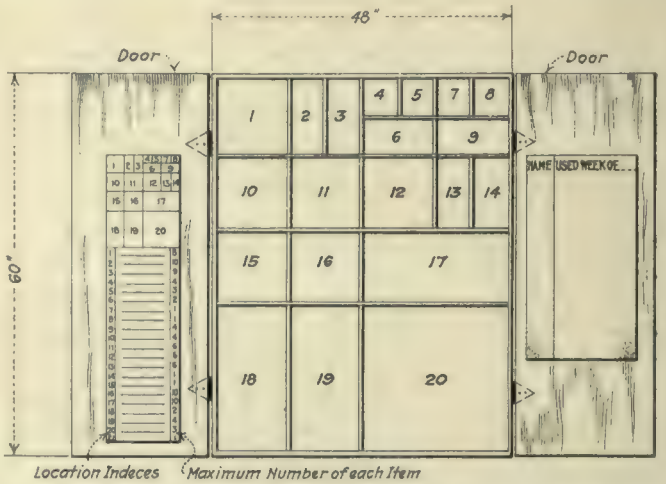

FIG. 14 THE LIMITED STORES CABINET IN WHICH MAY BE KEPT A WEEKLY SUPPLY OF BRUSHES, PENCILS, FORMS, OILS, ETC.

The procedure for the closed stores is similar. The entries are made on the closed stores balance card, Fig. 15, but a new card is used for each new shipment regardless of whether the goods were previously in stock or not. For such goods there will be no maximum and minimum quantity but as in the case of open stock the Material Ledger account number must be obtained in each instance.

The stores balance cards are arranged in alphabetical order—article by article. The groups are subdivided with indicators and each group again arranged in numerical order or other desirable subdivisions. For example: Number 60, two-ply cotton yarn will be subdivided according to colors, each color and shade according to shade, whether cones or cops. Thus, number 60 two-ply cotton yarn will be filed under the cot-

[5] No discussion of the method of purchasing is given for the reason that standard purchasing methods apply to the knitting as to other industries.

ton yarn group, after a higher number and before a lower number. If several ply yarns are in stock, of the same size, the subdivision will be according to plys.

Since the maximum and minimum stock limits are marked on the store control records, the storeskeeper

Closed Stores Balance Card						Mat. Led. Acct.
Article						No. of Units in Shipment
Test Sample Approved				Symbol		Receiving Date
Unit Number	Gross Weight	Net Weight	Location	Date Given Out	Reg. No.	Dept.

FRONT

					Balance in Stock	
Date	Unit Number	Gross Weight	Net Weight	Dept.	Gross Weight	Net Weight

BACK

FIG. 15 FORM FOR THE CONTROL OF CLOSED STORES

will compare the balance of stock on hand with the minimum limit as each disbursement is made. As soon as any article reaches the minimum, the storeskeeper advises the purchasing agent by issuing a purchase requisition.

THE DISTRIBUTION OF STOCK TO THE DEPARTMENTS

The distribution of stock to the departments is made only after receipt of the material requisitions by the department head. These requisitions are sent to the store by messenger. The store is always closed and all transactions with messengers must be attended to through the delivery window. The storeskeeper (or in his absence his assistant) receives the requisitions, and the goods are either handed over to the messenger or sent later by the storeskeeper to their destination.

The following is the procedure which the storeskeeper is expected to follow:

1. Requisition received
2. Proper store balance card taken from the file
3. Location of the goods determined
4. Stock selected and put on table
5. The quantity taken from stock deducted from the balance of the stores card (if there is a difference in quantity, this is marked on the requisition)
6. Material Ledger account number marked on requisition
7. Requisition put into the office clearing box
8. Goods given to messenger or to department.

Procedure When Stock Is Not on Hand. If the stock requested is not on hand, the storeskeeper makes out a purchase requisition, marks on it the department and the quantity requested, and attaches the material requisition to his order copy (sent to him after the goods are ordered by the purchasing agent). He also notifies the department of his inability to deliver the goods and makes, if possible, a promise of delivery. Such notifications must be made in written form. When such special goods arrive, the requisition attached to the order will eliminate all doubt as to the department that ordered the goods. If a requisition reaches the storeskeeper for an article of which he has no sufficient supply in the open stock but the stock of which is stored in cases or bales, he will transfer a case or a bale from the closed stock to the open stock records. The respective closed stock record is credited with the case or the bale, with a notation that it has been taken over to open stock and the balance corrected on the reverse side of the record.

For this stock an open stock record is made out and handled entirely as a new shipment under the open stock division.

If a shipment or any part of it arrives in damaged condition, the storeskeeper notes this on the stores receipt, making out an additional report on 3 x 5 cards in quadruplicate, of which one is sent to the purchasing agent, one to the general manager, one to the invoice clerk, while one is kept by the storeskeeper.

The purchasing agent is responsible for the proper procedure, but the others concerned keep these cards on file and investigate independently to see that pro-

Open Stores Balance Card					Location
Article				Symbol	Mat. Led.. Acct.
Test Sample Approved				Maximum	Minimun
Date	P. O. or Req. No.	Received	Dept.	Disbursed	Balance

FRONT

Date	P. O. or Req. No.	Received	Dept.	Disbursed	Balance

BACK

FIG. 16 FORM FOR THE CONTROL OF OPEN STORES

cedure has been taken in the case of damaged goods on the first Saturday of each month. All the cards for goods for which proper settlement has been made are destroyed with the exception of those held by the invoice clerk, who attaches her cards to the respective invoices, after noting on them the settlement.

In many knitting plants which manufacture their

own yarn in large quantities the problem of moving the raw material from the freight cars into the plant and of storing it is an important one.

The following illustrates a standardized procedure for such handling and storage of wool.

The first step required is to symbolize all warehouse space as shown in Fig. 17. The plan of symbolization is as follows:

First digit—floor
L—spaces to left of aisle from entrance
R—spaces to right of aisle from entrance
Final digit—spaces away from entrance

The information as to what material must be moved is obtained from freight invoices and shipping orders, and the overseer of sorting is consulted daily to learn what wool is to be delivered to him. Having notice of the arrival of wool, and supposing it is going into the warehouse, we look at the "Table of Space Requirements" (Table 2) to find what storage spaces are large enough.

In conjunction with this table a chart is used, showing what wool is stored in each section. This is mounted on a board 2 ft. 6 in. x 4 ft. 6 in. which is hung on the wall. At the top of each space is a small hook. As a lot of wool is placed in a section, the lot number and number of bales are entered on a small tag, which is hung on the proper hook. Thus a glance at the chart shows which of the sections is available that has the capacity for the lot being located.

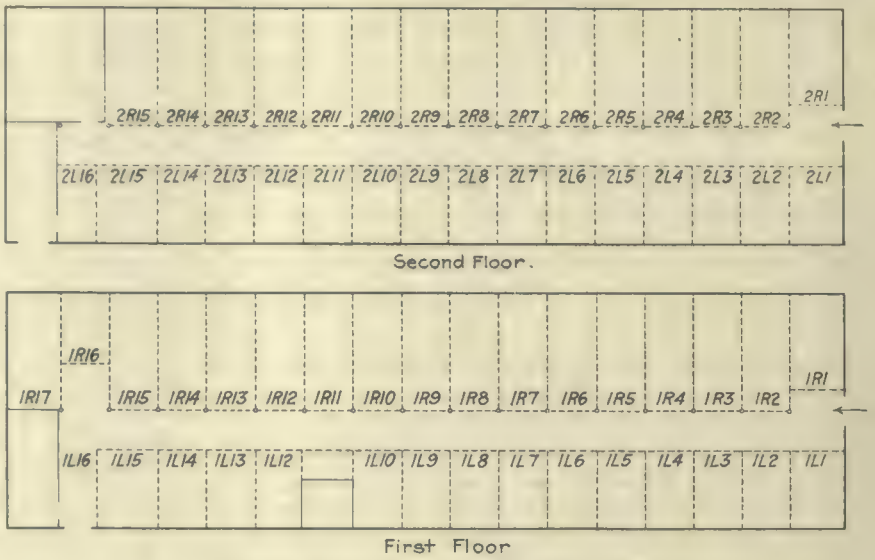

FIG. 17 PLAN OF WAREHOUSE STORAGE SPACE

The necessary time and labor is taken from schedules of standard loading time, and having determined where to put the wool, how many men are needed to handle it, and how long it is going to take, the job is scheduled on the Warehouse and Shipping Routing sheet. As a check on performance the Warehouse Foreman draws in with a colored pencil lines to represent the actual time when the jobs are started and finished.

TABLE 2. SPACE REQUIREMENTS FOR STANDARD BALES OF WOOL

To determine the location for a given number of bales look up the next highest "number of units" under the proper grade. Select any available section listed opposite this number.

GRADE	NO. OF UNITS	SECTION	PILING INSTRUCTIONS
Native Bags	36	W1L3 to 10 & 12 to 14. W135R16. W235L2 to 14	Header if over 20
	42	W5R2 to 14	Header if over 28
	48	W135L15	Three and One
	55	W1235R1	Three and One
	55	H12R1	Header if over 51
	65	H1L1	Header if over 54
	70	H12R2 to 14	Three and One
	78	W135R17	Ends out
	85	H1L2 and 3. H2I.2	Three and One
Montevideo	8	W1L11	One end—Two High
	20	W13R16. WSR2 to 16. WIL3 to 10 & 12 to 14. W235L3 to 14	One end—Two High
	24	W1235R1	
	26	W1235L15	
	32	W123R2 to 15. W13R17	
Australian	30	H12L11 & 12	
	40	H12L10. H2L4	
	45	W135R16. W1L3 to 10 & 12 to 14	
	45	W235L3 to 14. W5R2 to 15. H12L9	
	60	W1235R1. W1235L15. H12L8	
	70	H12L7	
	75	W123R2 to 15. W13R17	
	80	H12L6	
	90	H12L5	
California	42	WIL3 to 10 & 12 to 14. W5R2 to 15. W235L3 to 14	Three wide
	51	W1235R1	
	57	W1235L15	
	60	W123R2 to 15. W135R17	
Cape	50	W1235R1. W135R16. WIL3 to 10 & 12 to 14	Two wide
	50	W235L3 to 14. W5R2 to 15	
	56	W1235L15	
	70	W123R2 to 15. W13R17	

CONCLUSION

It will be observed that the method described provides the proper equipment for:

1. Knowing where material should be placed.
2. Knowing how long it will take to handle.
3. Giving daily detailed instructions to workers.
4. Receiving detailed time reports on performances.

Scale Selection for Z Charts

Bringing the Basic Facts of the Industry Into the Same Focus

By ARTHUR R. BURNET*

Consultant in Business Statistics

EVERY person undertaking to draw a chart is confronted with the problem of scale selection. Since numbers are to be represented by varying heights on the chart paper, units of value for fixed distances are chosen, or, in other words, a scale is decided upon. The attaching of a value to a certain distance above zero, and the determination of what that distance shall be, are called scale selection.

Formerly each chart presented an individual problem in scale selection, the limitations of which were chiefly the size of the field, the good appearance of the chart, the fixed rulings of the chart paper, and the convenient readings when the engineer's scale was held at right angles to the zero line of the chart. There was no selection of scales on the basis of a scientific system which required that certain scales should be chosen because of the relation of one chart to another. There was no system at all.

Recently a definite system of scale selection has been worked out, which is based on the fundamental principle that curves are comparable according to the rates of increase or decrease which they represent on ordinary arithmetic paper only when the curves occupy approximately the same location on the chart field. The desirability of rate comparison (as distinguished from absolute comparison, in which the scales are identical) is apparent when it is remembered that the most useful comparisons within an industry are relative comparisons, e.g., the rate of production of one department as compared with the rate of production of another department, disregarding size.

The Summation Method

In order to place the curves in similar locations on the fields of management engineering charts, the best method is the "summation method" or the locating of certain totals at approximately the same distance above the zero in each chart. There are other methods of securing the same result, but this has been found to be the most practicable for Z charts having the three curves; the current, the cumulative, and the moving annual total.

The totals just referred to represent the results of operations for periods that are regarded as normal, or at least sufficiently typical to be used as bases of comparison. A base year is chosen in the case of monthly and weekly charts because of the habit of managers to compare the results of one year with another, or one month with the corresponding month of another year. The average management engineer thinks in terms of a year's business, whether he keeps his records by months or by weeks. He is accustomed to say: The results of this year are better or worse than the results of that year, or the current progress of one year, month by month, is better than the progress of another year. Similar comparisons are made between weeks, months, days, or other periods.

Now, the period that is used as the basis of comparison is called the base period, and in management graphics it is chosen with great care because it is used for measuring both past and future performance. So far as is possible, this base period is a period when conditions are normal, or when one department or section of the industry is properly related to the whole. For that reason there may be different base periods for individual products or for certain departments or other divisions of the industry.

Standard Chart Forms

Experience in management graphics has approved for executive control purposes a chart form that is printed or otherwise prepared with five horizontal rulings located one inch apart. The inch spacing is especially desirable because the engineer's scale is designed to divide 1-in. spaces into 10, 20, 30, 40, 50, and 60 equal parts, and this arrangement makes possible a great variety of units of measurement. The omission of intermediate horizontal lines dividing the inch spaces into fifths, tenths, or twentieths, as in the familiar commercial chart paper, not only makes the curves stand out more clearly, but also allows the drawing in of special and very significant lines which do not appear in the blank chart forms as printed. Two highly important results of the above plan for chart paper are:

1. The showing of both natural and percentage scales.
2. The great enlargement of the range of scale selection.

We are now brought to the problem of locating on the field the total for the base period. Experience has dictated that in a chart having a field 4 in. high, with

* Mr. Burnett has specialized in economic statistics. From 1915 to 1917 he was statistician for J. H. & C. K. Eagle, silk manufacturers, where he made statistical analyses of production, sales, and the financial situation of the company. He also instructed ten other men in the application of statistical methods to the silk business. Since 1917 he has been employed in the introduction of statistical departments in industrial establishments. This work has been done both as a member of a staff of engineers specialized on this work and as an independent consultant.

the zero and inch lines as described above, the total for the base period should be plotted at the second inch line. This total may, of course, have a great variety of values, large or small, yet since we wish to follow the principle by which charts are rendered comparable relatively, it is necessary that this total in the case of each individual chart should be located always at the same height.

It is evident, therefore, that a great variety of units of measurement or scales is required in order that the value for the base year may be plotted on the second inch line, and that all the other plotted values may be proportionately located. Strictly interpreted, the principle for producing relative comparability in charts would demand an almost infinite number of units of measurement. In practice, however, it is necessary to modify the demand by assuming that for the purpose of locating the total for the base period at the second inch line, only the first two significant figures of that total will be used. For example, if the number is 23,463, we locate 23,000 on the second inch line instead of the complete number. The disregarding of the last three digits makes no appreciable difference in the appearance of the curve, but it greatly reduces the work involved and saves time.

It is just at this point that the scale selection tables come into play. These tables have been worked out for the sake of convenience, their purpose being to show just what side and position of the engineer's scale needs to be used in order to locate the first two significant figures of the total for the base period exactly at the second inch line. Therefore, in these tables, every number is given from 10 to 99, inclusive, since such a list includes the entire range of numbers having two digits.

Oblique Use of the Engineer's Scale

It has been discovered that the engineer's scale as heretofore used for curve plotting, namely, at right angles to the zero line, does not supply the necessary range of choice in units of measurement. Referring to the base year total given above, no side of the engineer's scale can be found which reads "23" at the second inch line, when the engineer's scale is placed at right angles to the zero line of the chart, the zero on the chart and the zero on the engineer's scale coinciding. But by applying the engineer's scale in an oblique position, the range of choice is increased indefinitely. The use of the engineer's scale in this slanting position is founded on the geometric principle that in a right angle triangle, parallels to the base cut both the hypothenuse and the side in the same proportions.

Mechanical Plotting Devices

Before we can illustrate the practical application of the oblique position of the engineer's scale and the actual use of the scale selection tables it is necessary to describe the mechanical plotting devices which are an inseparable part of this system of chart-making. The mechanical devices consist of a plotting board and a scale holder. The main purpose of the plotting board is to hold the chart paper in such a way that the zero line of the paper will be exactly parallel with the left-hand edge of the board. By means of the scale holder the engineer's scale can be made to travel along the edge and the operation of plotting is greatly shortened. It is estimated that this method of plotting and checking, exclusive of the use of the scale selection tables, has cut the plotting and checking time in two.

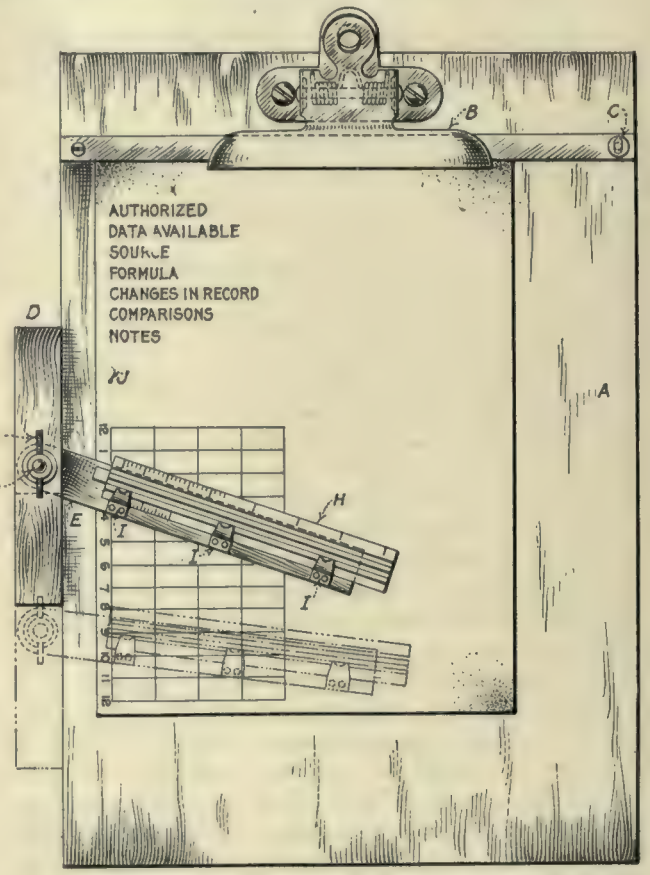

Fig. 1 Plotting Board and Scale Holder

A device for quickly squaring up the chart paper and holding it in the proper position for plotting. The combination of the plotting board and scale holder makes the oblique use of the scale commercially possible, and greatly facilitates the production of the charts.

The general construction of the mechanical plotting devices is shown in Figs. 1 and 2, the various parts of which are as follows:

A. Drawing board, preferably 12 by 17 in. for standard 8½ by 11 in. charts.

B. Spring clip with broad jaw.

C. Strip or straight-edge, passing under the jaw of the clip. This strip has a slotted hole at one end so that it can be set perfectly square with the edge of the board. Another form of the board does not have this straight-edge, but instead has a thin strip of metal or paper parallel to the side of the board along which the scale holder travels. If this form is used it will not be necessary to have the chart paper absolutely square, so long as one edge of the chart paper is perfectly parallel with the zero line of the chart.

D. The back of the scale holder rests against the edge of the plotting board and can be moved along in the same way a T-square is moved. The scale holder is sometimes fitted to the edge of the drawing board by means of a tongue and groove so that the board and holder become a single piece of mechanism.

E. Tongue of the scale holder, which swings around the screw (F) and can be held in any position by the winged nut (G).

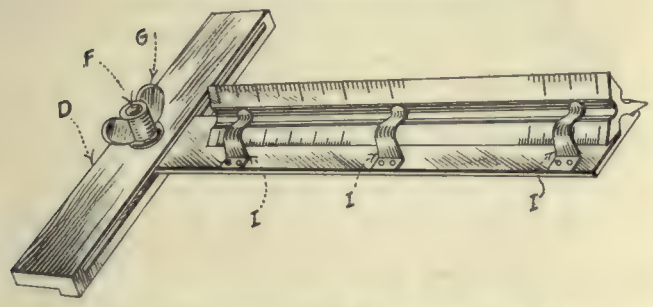

FIG. 2 DETAILS OF THE SCALE HOLDER SHOWN IN FIG. 1

When curves are plotted with the help of the engineer's scale the zero on the scale must be exactly over the zero line on the chart. To maintain this position by hand is difficult enough when the scale is at right angles to the zero line of the chart, but it is almost impossible when the scale is in oblique positions. The holder keeps the scale in the correct position at all times, and is quickly adjusted to any angle required by the scale selection tables.

H. Engineer's scale, held to the tongue by means of springs (I) which permit the scale to be removed quickly when it becomes necessary to use another side of the scale. The springs hold the scale with sufficient firmness and yet permit the sliding of the scale so as to bring zero on the scale exactly opposite the zero line on the chart paper.

SCALE SELECTION TABLES

We turn now to the exposition of the scale selection tables, with which the plotting devices are used. Although there are several kinds of scale selection tables, as, for example, yearly, quarterly, monthly, weekly, and daily, the monthly table, a portion of which is reproduced in Table 1 is typical and illustrates the principles on which the others are based.

In column A of Table 1 all the significant numbers of two digits will be found and these are placed in groups of five for convenience in reading. If the total for the base year is 2426, the significant number to be used in connection with this table is 24, and it is found in column A.

Column B shows which of the six different graduations on the three sides of the engineer's scale is to be used. It will be remembered that the engineer's scale divides inch spaces into 10, 20, 30, 40, 50, and 60 equal parts. (Smaller divisions are undesirable on account of the difficulty of reading and the fact that smaller distances than sixtieths of an inch cannot easily be shown by means of curve lines of a width that is necessary to construct good, clear, readable charts.) Referring to the row of the table in which the significant number 24 appears, we find in column B the figure 20. This means that the "20" side of the engineer's scale is to be used.

In column C is found the reading on the 20 side of the scale which must be placed over the fourth inch line while the zero on the engineer's scale exactly coincides with the zero line of the chart. Thus it is seen in Fig. 3 that the slanting scale A reads 9.6 at the fourth inch line. The fourth inch line instead of the second inch line is chosen for this reading simply because a wider spread between points gives greater accuracy and speed. The slanting lines placed before the numbers in column C indicate that the scale is to be used in the oblique position. The importance of such use is shown by the comparatively large number of slanting lines.

TABLE 1. DATA TAKEN FROM A MONTHLY SCALE SELECTION TABLE

CURRENT				CUMULATIVE AND MOVING ANNUAL TOTAL		
Sig. No.	Side of Scale	Read 4th Inch	Value of One Unit on the Engin. Scale	Side of Scale	Read 4th Inch	Value of One Unit on the Engin. Scale
A	B	C	D	E	F	G
10	10	4.0	1000	50	20.0	1000
...	...	...	....	...	...	....
...	...	...	....	...	...	....
20	20	8.0	1000	10	4.0	10000
21	20	/8.4		10	/4.2	
22	20	/8.8		10	/4.4	
23	20	/9.2		10	/4.6	
24	20	/9.6		10	/4.8	
...	...	...	....	...	...	....
...	...	...	....	...	...	....
99	60	/39.6		40	/19.8	

Column D shows the value of one unit on the engineer's scale for any given reading. By "unit" is meant the major divisions that are marked 1, 2, 3, 4, etc., on the usual engineer's scale. For example, in the same row in which the significant number 24 appears in the table, the value of the unit is given as 1000. This rests on the assumption that the number of places in the total for the base year is five, or of the same form as 10000. Therefore, if the total for the base period has more or less than five places, the number of places of the amounts appearing in column D must be altered accordingly. Thus, the value of the unit is 100 in the case where 2400 represents the total for the base year, or one place less than the 1000 shown in column D.

So far, we have described the first four columns of the table. Columns E, F, and G, respectively are similar to columns B, C, and D. The difference is that the first three concern the current monthly or solid black curve (Fig. 3) while the second three, E, F, and G, concern the cumulative and moving annual total curves shown in the figure as broken lines.

It will be noticed in Fig. 3 that the two sets of scale figures at the left of the chart stand in a 1 to 5 ratio. This ratio has been selected partly by experiment and partly for mathematical reasons as the best relation in which the curves should stand on the field of the standard Z chart. Since a year is roughly 12 times the monthly average, the annual curves would run off the field if plotted on the same scale with the current curve. Because current curves are compared only with current curves, and annual curves only with annual curves, no confusion arises from the use of different scales for each. The ratio between the scales varies with the kind of chart, whether monthly, weekly, daily, or otherwise. In Table 1 the 1 to 5 ratio can be observed in the readings at the fourth inch line which are given in columns C and F. For example, in row 24, five times 9.6 gives the number 48.0. But the table records 4.8 instead of 48.0 because that is the actual reading on the scale.

The fixed ratio between the current and cumulative scales will always bring the current curves in the proper position for relative comparison when the corresponding annual curves are properly located.

Scale selection tables and mechanical plotting devices simplify the making of executive control charts to such an extent that charts of this kind can be turned out accurately, quickly, and cheaply by the ordinary typist after a little instruction. The relegating of this work to inexpensive help gives the managers more time to make analysis and to apply the results. Let us now turn to a concrete example of the use of the tables and devices by which these desirable ends are secured.

A Concrete Example

The chart in Fig. 3 originally had no lines on it except those that are marked "green" and "blue." (Incidentally, the blue lines are rulings similar to those found in accounting books, and the chart itself shows how the data can be put in by hand by the accountant if necessary without waiting for a typewritten copy to be made.) Let us begin, then, with the foundation lines. The chart is a Z chart and represents an item in general expense for the year 1919. Therefore, the cumulative and moving annual total amounts are computed, and typed or written in the proper space. It is seen that the expense in January is $188, the cumulative from the beginning of the year to July is $1454, and the total for the twelve months ending with October is $2525.

Let us assume that the base year is 1919. Since the total for the year is $2426, the first two significant figures are accordingly 24. Referring to Table 1 we find 24 in column A, and write down on the chart opposite the dot (designated as J in Fig. 3) the information given in the horizontal row in which 24 appears:

20/9. 6-100 10/4. 8-1 000 100%-2 400-1919

The above is known as the plotting formula and is not to be confused with the word "formula" printed on the chart which refers only to the elements entering into the data. The plotting formula contains three sections, the first referring to the current monthly curve, the second to the cumulative and moving annual total curves, and the third (the information for which does not appear in the scale selection table) showing the total for the base period and the date of that period. One place was taken away from the figures of columns D and G because 2400 has one less place than five.

The 100 per cent in the third section of the formula means that 2400 is to stand at 100 per cent on the percentage scale indicated at the side of the field. Therefore, 2400 virtually becomes the base of an index number represented graphically by a distance of 2 in. above zero. When the moving annual total curve in a future year falls to one in. it is easy to see that the amount it

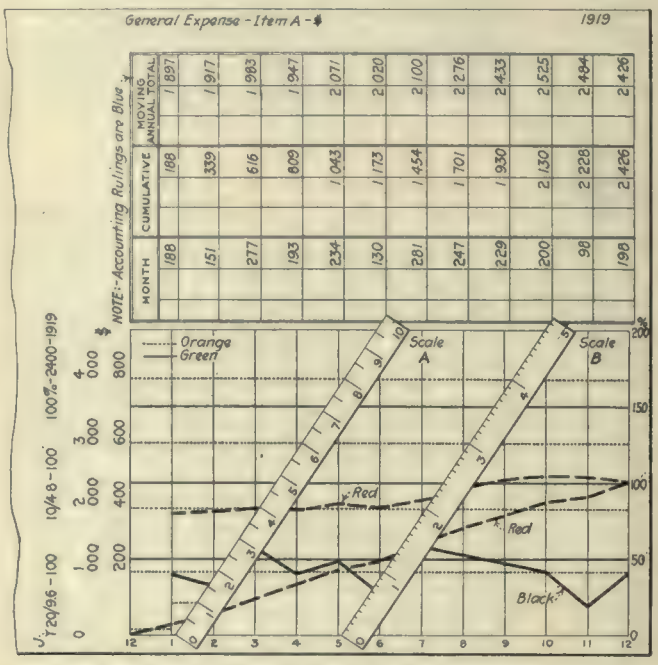

Fig. 3 Oblique Use of the Engineer's Scale

Scales A and B have been drawn over the face of this chart to show the readings when the engineer's scale is adjusted to the angle called for by the scale selection table. Note that the chart has two sets of horizontal rulings, one designated by the percentage figures at the right, and the other by the natural scale figures at the left. The percentage rulings are fixed and unchangeable, while the rulings of the natural scale always pass through easy readings on the engineer's scale, such as 1-2-3, 2-4-6, etc. The fixed position of the percentage rulings, the oblique use of the engineer's scale, and the reference to scale selection tables, are the means by which all the charts are brought into the same focus.

represents is 50 per cent below that of the base year. Likewise, if the moving annual total rises to the third inch line the increase has been 50 per cent. When the item of expense represented on this chart is plotted for the years 1920 and 1921, and until such time as a change in conditions necessitates a change in the selection of the base year, the scales of this chart for 1919 are used in order that other years may be properly compared with the base year 1919. The second inch line, representing in this case the base number 2400, becomes a normal line or a line of reference by which comparisons between the base period and any other period can be quickly made.

The next step is to make use of the plotting formula which has just been taken from the scale selection table.

The "20" side of the engineer's scale is found, and the scale inserted into the scale holder. Assuming that the chart paper is already on the plotting board as is shown in the assembly view (Fig. 1) the engineer's scale is adjusted at the angle shown by scale A in Fig. 3. It is seen that the zero of the engineer's scale rests upon the zero line and that the reading at the fourth inch line is 9.6 as required by the first section of the plotting formula. Similarly, the "10" side of the engineer's scale is seen in scale B of Fig. 3, and the reading at the fourth inch line is 4.8 as required by the middle section of the plotting formula.

The percentage scale has already been written opposite the zero, first, second, third, and fourth inch lines. The rulings that are designated in the figure as "orange" lines represent the natural scale of dollars, and are located at the even units of the engineer's scale. Note that these lines run through 2, 4, 6, 8 on scale A, and through 1, 2, 3, 4 on scale B. The "orange" lines are drawn in by hand since their location will be different in almost every set of charts. The values of the unit (columns D and G) are given in the formula, from which it is easy to see that the "2" on scale A represents 200 and the "1" on scale B represents 1000. These numbers and their multiples are placed opposite the proper orange lines, thus establishing on the chart the natural scale of dollars.

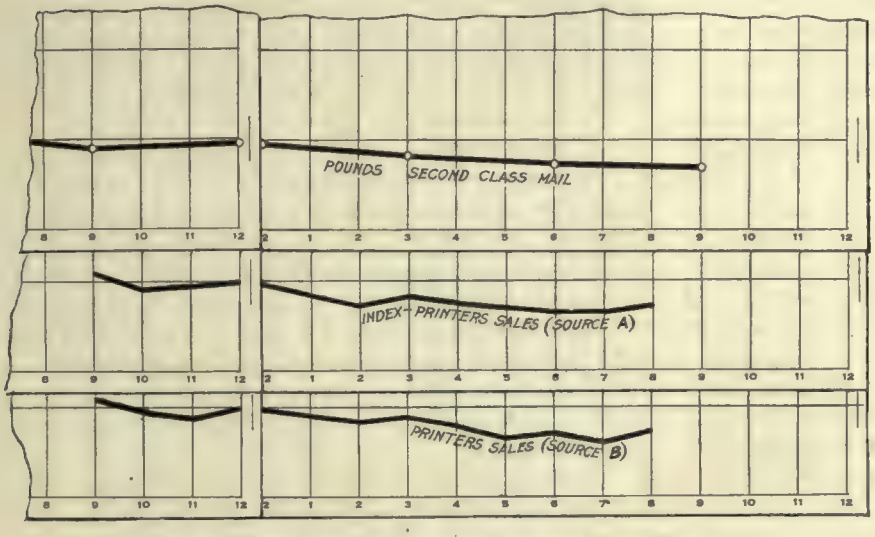

FIG. 4 THREE CURVES BROUGHT INTO THE SAME FOCUS

The devices described in this article were used in plotting these three curves, each one of which represents a different unit. The result is three curves that are comparable according to their rate of increase or decrease for the whole period, which is seen to be nearly the same in all three. The curves can also be accurately compared for their "variability," as shown by the smoothness or roughness of the lines.

PLOTTING THE CURVES

We are now ready for the plotting. Beginning with the current monthly amounts (solid curve) the values for the successive months can be quickly read on scale A by simply sliding the scale holder along the edge of the plotting board. The same process is followed in the plotting of the other curves. The plotting can be checked in like manner. For making single entries on a large number of charts the charts can be sorted out in groups according to the settings required by the plotting formula and each group plotted without changing the side or the angle of the engineer's scale.

The reader may ask whether in periods following the base period the curves that were perfectly comparable will diverge so much as to become incomparable? This sometimes happens, but the very divergence is a striking signal of the abnormal relation of the values represented by the spreading curves. Occasionally it becomes necessary to choose a new base year, thus securing a new index number for the second inch line.

Limiting the height of the chart field to 4 in. is particularly advantageous because it makes necessary the replotting of curves so as to keep them fairly within the range of comparability.

A practical example of the value of scale selection is seen in Fig. 4. Three curves are plotted on three individual cards each with its own field rulings and its own scales as required by the scale selection table. The charts are overlapped so as to bring the curves close together. The lowest curve represents the monthly billings of printing plants in a large city, the middle curve represents for the same city printers' sales as reported by one of the large paper manufacturers, and the uppermost curve represents the number of pounds of second class mail matter received at the post office in that city at quarterly periods indicated on the chart by the small circles. The units of measure are not the same in all three cases. Billings are in dollars, printers' sales are in the form of index numbers. and second class mail matter is in pounds. How can such dissimilar units be compared on ordinary arithmetic paper? Manifestly, the comparison must be between the rates shown by the slope of the lines, and their parallelism with each other or their divergence.

In order to bring the curves into proper focus so that they may be compared relatively, the scale selection table has been used in each case. The table is based on the principle, that curves are comparable relatively on arithmetic paper only when they are plotted at approximately the same distance above zero. Scale selection puts consistency into a graphic system, and makes comparison between curves safe. In the case illustrated, it is seen that billings, the index of printers' sales and second class mail matter are falling off at about the same rate, which is in entire accord with the facts.

The reader who is not familiar with this kind of comparison may think at first glance that the curves are not very significant because they are flat and smooth. But it should be remembered that the general movement or trend of a curve is often fully as important as a succession of sharp peaks and deep valleys. The very smooth-

ness may be an important part of the story. If conditions had been more uneven there would have been more fluctuation in a given curve. When the smoothness or roughness of curves is automatically governed by the numerical facts through the medium of the scale selection tables, the charts will show the executive true and consistent pictures, all of them in focus whether he has ten charts in his system or ten thousand.

Too little attention has been given to this vital point in business graphics. It is one thing to draw a chart or two to illustrate a special study or a report, but it is quite another thing to establish graphic control for the current management of a large enterprise involving, as it does, a multitude of interrelated factors. In the first case little or no regard need be paid to scale selection, but in the latter case scale selection is absolutely indispensable. The managing executive must be able to see not merely that the curves have gone up or down, or that so many dollars or pounds are represented by their rise and fall—he could get that much from the figures alone—but he must also be able to compare rates and trends, and he must be able to tell at a glance which elements of his business are irregular, inconsistent and out of line. Scale selection makes it possible for business graphics to meet this demand.

Incidentally, Fig. 4 illustrates the way unit charts can be arranged either for the purpose of quick analysis or for making permanent photostat records. The charts can be placed in many useful combinations as may be required by the needs of different executives within an industry or to suit the purposes of special studies.

The method of chart-making and curve plotting described in this article is so new and contains so much that is unfamiliar that it may be well to compare the old and the new in parallel columns:

THE OLD METHOD	THE NEW METHOD
1. Scale figures chosen by inspection, no definite rule or principle being followed.	1. Scale figures chosen quickly and systematically by means of *scale selection tables.*
2. No base year used. Any year was considered to be of equal importance with any other year.	2. Definite year or other period chosen as the *base* for purpose of comparison.
3. No definite height to represent total for the base year. Curves were located so as to look well on the page or else to allow for future expansion. Comparison of rates between two arithmetic charts is not ordinarily possible.	3. Definite height chosen to represent the total value for the base period. This height is usually 2 in. Therefore the *second inch line* can be used as a normal line, and the chart read in percentages, or comparisons made between two or more charts to show rates.
4. Chart paper loose on desk, or if attached to drawing board it had to be squared up by T-square or other means.	4. Chart held square mechanically on *plotting board.* This helps the plotting and checking.
5. Engineer's scale held by hand. Difficult to keep zero on the engineer's scale directly over the zero line on the chart.	5. Engineer's scale held in correct position by the *scale holder* and moved along the board, zero on the scale being always over the zero line.
6. Engineer's scale held by hand at a right angle to the zero line of the chart. This limited the values that could be read on the engineer's scale.	6. Engineer's scale held accurately at *any predetermined angle.* This vastly increases the number of different values that can be read on the scale.
7. Necessary to keep on hand at least three kinds of chart paper having arithmetic rulings corresponding to the three sides of the engineer's scale.	7. *Only one kind of arithmetic paper* necessary for any given time period. Intermediate rulings, if required, can easily be located by means of the slanting scale.

Power plants. Management 621.311 : 658
Management engineering. Power plant 658 : 621.311

Waste in Industrial Power Plants

By DAVID MOFFAT MYERS

Griggs and Myers, Consulting Engineers

HIGH coal prices and poor quality mean high cost of power in manufacturing plants, and to bring about a lower cost of steam and power there are two methods, and only two, that will produce results:

1. Improvement in the design or equipment.
2. Improvement in the method of operation.

The second method was largely used during the war, when new or improved power equipment was not obtainable. Yet 25,000,000 tons of coal were saved annually merely by improvement in operation alone, by getting the utmost efficiency from existing equipment, and this without any capital expenditure. This was indeed an example of true economy, as much for the benefit of the individual plant owner as for the nation in whose sole interest the plan was conceived and put into operation.

With the signing of the armistice came a great and natural relaxation of effort. Money was easy. Business was booming. Prices were high and good profits could be made without worrying about the cost of steam and heat and power. But those days have now long gone by and manufacturers are confronted with the problem of economy of production with an urgency that perhaps has never before been experienced in this country. The great life and death incentive of "Winning the War" is now but a record of history. But a new incentive has arisen, the urge to save industry itself, for it is most surely threatened.

How 25,000,000 Tons of Coal Were Saved

What could be more natural, then, what more quickly and decisively effective, than to turn back to the lessons learned during the war? Twenty-five million tons of coal saved without buying new or improved equipment; and only the very surface of economy was scratched when the armistice put an end to further accomplishment in this direction.

The job of saving fuel and labor during the war was a rush job and was done on a big scale; hence it could not be done thoroughly. Yet plant owners reported economies of from 10 per cent to 30 per cent. With the thorough individual attention that can now be given to each plant the savings will be still greater, and now is the psychological moment to discover and produce these economies. In one case of this kind the evaporation was increased from 6 lb. to 9 lb. per lb. of fuel. Half the boilers were shut down and 50 per cent more

steam was made for the same coal consumption and no change in equipment was required. A small sum for a few instruments constituted the entire investment.

There is scarcely an industrial power plant in the country today in which a saving of from 10 to 30 per cent could not easily be effected, and that without any change in boiler or engine room. The first requirement towards this improvement is exact knowledge of existing performance. An equipment of the proper kind of recording instruments (selected in accordance with local conditions) will give this information. Without such means of information the operation of the plant is literally blind, and, in fact, most plants today are being run without eyes. Unless the management will provide suitable eyes in the way of properly selected instruments, the chief engineer and his staff cannot discover the faults, the weak spots, the losses and wastes of steam and fuel and power.

How to Determine the Efficiency of Operation

This, then, is the first step: To have the plant suitably equipped with instruments, thus enabling the management to know (1) the efficiency of the plant under regular daily conditions of operation; (2) whether each boiler is carrying its share of the load efficiently; (3) whether the combustion is right, and if not, why not; (4) how much steam is being produced and where it goes; (5) whether the owner is really getting the quality of coal he is paying for, and (6) whether it is the best kind for furnaces and steaming conditions. By the use of proper instruments these and many other questions essential to economy are answered, and with each answer dollars are saved.

The instruments required are a simple equipment correctly prescribed for each individual set of plant conditions and layout. Their readings can be readily understood by the firemen, who are enabled by watching them to know whether they are getting proper results, and if not, they can tell immediately what corrections and adjustments are necessary in the control of drafts and firing to produce the highest efficiency with the desired capacity. The otherwise invisible and unnecessary losses are made evident for correction and conservation. The operation of the plant is no longer blind, for it has been supplied with eyes to see. The time has long gone by when a plant having any claim whatever to efficient operation can be equipped merely with steam gauges and safety valves. That time belongs to the dark ages of fuel waste and inefficiency.

Just now, when no one wants to lay out new capital, a general movement should be started for improvement by means of purely operating economies. Wartime economy is the keynote for the reestablishment of peace-time prosperity.

Incidentally the first step necessary for the further improvement that can be obtained by changes in the design of power plants consists in securing this very same information which leads so directly to those marked economies in operation just described.

Consequently by taking the first step now, which requires no capital expenditure, the foundation is laid for such future improvement and design as will make the power plant highly economical both from the standpoint of equipment and of operation. The equipment changes can perhaps be deferred, but the plans will be made and the mill or factory will be prepared in advance for the rising tide of business. When this new business comes with the pressure it will bring upon all executives, the organization ought not then be handicapped with the necessity of studying plans for economical power and heat. The new conditions of business will not be like the old, when even the most wasteful plants could make money and show a good profit. It will now be necessary that every department of the establishment be designed for the most thorough-going efficiency together with the lowest cost of operation. The power and heating cost may kill the profits. No manufacturer can afford to have that happen.

What is the most economical kind of boiler, furnace, fuel, prime mover, heating system for the special conditions of a particular manufacturing plant? What are the most modern and efficient methods for utilizing the waste heat from exhaust steam and from other sources in such manner as to apply it effectively to local conditions and requirements? How should combustion be controlled in any particular design or boiler plant? How should waste be stopped in connection with the generation of steam and electrical energy, and how may the losses in connection with their distribution and application be prevented? Is it realized by owners and managers that there is almost as much heat in exhaust steam as there is in live steam direct from the boilers, and that where exhaust steam can be utilized the saving in fuel is about five times as great as when the plant is run condensing? Is it thoroughly understood throughout the industries that connecting a prime mover to a condenser reclaims only from 10 to 20 per cent of the energy in the exhaust steam, whereas practically 100 per cent of this energy can be recovered if applied to building heating or process work? Is it known that power purchased from outside will cost more or less than if produced in the power plant of a given factory or mill? How many managers fully appreciate the relation of heating and process requirements to this important problem? Each of these questions brings forth a problem vital to economy.

Time to Secure Information Now

It takes time to secure authoritative information on these points as applied to any given plant. No one plant can copy the design of another. The correct solution in any plant depends upon correct application of engineering principles to its particular conditions and requirements. Still more time is necessary to secure the equipment that may be found necessary to economy. Additional time is then required for preparation of plans and specifications and for installation of equipment. Any delay in these matters now will be reflected in reduced profits, and the industry suffering such delay at present will have less chance of securing its share in the highly competitive business of the coming era.

The Superpower System Report

An Abstract of the Findings Dealing With the Industries in the Superpower Zone

IN the report on the superpower system for the region between Boston and Washington we have another engineering paper of importance to industry. The wastage of fuel that it reveals is cumulative evidence supporting some of the recommendations of the report of the Committee on the Elimination of Waste in Industry.

The investigation upon which the Superpower Report is based was begun July 1, 1920, and finished a year later. It was made possible by an appropriation of Congress of $125,000 to the United States Geological Survey. In addition to this sum, under the specific authority of Congress, $26,000 was contributed by 38 corporations and individuals representing utilities and industries in the zone.

The work was done by W. S. Murray and others. The completed report represents the concordant action of a large number of minds.

In the general discussion of the application of the superpower system there has been some tendency to think of it as a plan for a superpower company to supply power, rather than as a principle for development. In reality, the term "superpower" is merely a name for the principles that should govern the expansion of existing electric utilities to provide for future needs and to secure maximum economy.

From this report the abstracts which follow have been taken from those sections which apply particularly to industries in the superpower zone.

Summary of Conclusions

The market for superpower energy will be furnished by the electric utilities, the industries, and the railroads. The estimated requirement for energy supplied through the electric utilities for municipal, private, industrial, and railroad purposes in 1930 is 31,000,000,000 kw-hr. This energy could be supplied by a co-ordinated power system such as is described in this report at an annual cost of $239,000,000 less than by an unco-ordinated system such as is now in use. This amount represents the net saving after the necessary fixed charges on total capital expenditure have been deducted. The cost of unco-ordinated power production in 1930 is computed from the cost of the present system in 1919. The total investment in generating and transmission facilities for the superpower system will be $1,109,564,000, of which $416,346,000 will represent the value of existing facilities to be incorporated into the system.

A study of the 96,000 manufacturing establishments operating within the superpower zone shows that by 1930, through the maximum economical use of purchased electric energy, they can save $190,000,000 annually above the fixed annual charges against a capital investment of $185,000,000 to provide the motor equipment necessary to receive and use this power.

The combined capital investment necessary for the electric utilities and the industries as of 1930 therefore amounts to $1,294,564,000, and this total investment will yield annually above the fixed charges the sum of $429,000,000, or 33 per cent on the investment.

Within the superpower zone there are 36,000 miles of railroad measured as single track—that is, including each track of main lines, yards, and sidings. Of this total about 19,000 miles can be profitably electrified, so as to yield by 1930 an annual saving of $81,000,000 as compared with the cost of operation by steam. The capital expenditure necessary to electrify the 19,000 miles would be $570,000,000, and the average return upon the investment would therefore be 14.2 per cent.

As defined in another section of the report, the superpower system begins at the generating stations connected to its lines and ends at the busses of existing electric utilities. Therefore, the cost of power discused in this report means cost at the busses of the electric utilities, and must not be confused with the cost to the ultimate consumer, which is necessarily much greater, owing to the added cost incident to secondary distribution systems.

Studies of the operations of each load center have shown that a large quantity of coal could have been saved had superpower facilities been available in 1919. On comparing the coal rates of power production in 1919 with those of the superpower system and applying the difference to the load that will exist in 1930, we find that the coal saved annually under the superpower system may estimated as follows:

	Short Tons
Electric utilities	19,149,000
Heavy-traction railroads	10,210,000
Manufacturing industries	20,625,000
Total	49,984,000

The order in which the superpower steam-electric and hydroelectric power plants and transmission systems should be constructed must depend (1) on the present industrial demand for energy that cannot be satisfied because of the difficulties of the local electric utilities in financing extensions; and (2) on the future demand for energy that will result from the more economical generation of power under the superpower system.

Many of the economies incident to superpower operation will be effected through the interconnection of existing plants and systems, and these economies should be increased as new power plants and interconnections are added. Certain steam plants that are under consideration and others that are under construction, will be when completed as efficient as the proposed baseload steam-electric plants of the superpower system. Notable among these plants are the Hell Gate station now being constructed by the United Electric Light & Power Company of New York City and the Delaware station of the Philadelphia Electric Company. However, by keeping in mind the two conditions, already stated, that should govern the order of construction, it is believed that the quickest return will be obtained by following in chronologic sequence the order of procedure outlined below:

1. The construction of a steam-electric plant near Pittston, Pa., to supply a part of its energy to the anthracite division of the superpower zone and the remainder to the Metropolitan division, particularly New Jersey.
2. The construction of a steam-electric plant near Sunbury, Pa., to supply a part of its energy to the anthracite division, a part to the Reading load center, and the remainder to Philadelphia.
3. The construction of hydroelectric plants on Delaware and Susquehanna Rivers to supplement the steam plants indicated in paragraphs 1 and 2.
4. The progressive development of the Hudson River projects to meet the growth of energy requirement at the Schenectady, Utica, Poughkeepsie, and Pittsfield load centers.
5. The construction of a steam-electric plant near Boston to supply the Boston, Lowell, and Newburyport load centers.

6. The construction of a steam-electric plant near New Haven to supply the New Haven, Bridgeport, Waterbury, and Norwich load centers.
7. The partial construction of the first hydroelectric plant in the development of Potomac River as soon as the power demands of the Baltimore and Washington load centers require additional plant capacity.

Plant capacities are not stated above, as they cannot be finally determined except by further and more detailed study of local conditions combined with regional demands. The load growth at all the centers, however, will make it imperative to provide new plant capacity at an early date, so that the construction of additional plants must be started promptly after the plants that will yield he greatest return have been built.

THE SUPERPOWER SYSTEM

The territory in which the superpower survey has been made—the "superpower zone"—may be described as lying between the thirty-ninth and forty-fourth parallels of latitude and extending from the coast approximately 150 miles inland, embracing parts of the states of Maine, New Hampshire, Vermont, New York, Pennsylvania, Delaware, and Maryland, and all of the states of Massachusetts, Rhode Island, Connecticut, and New Jersey. Within this zone is concentrated one-fourth of the population of the United States, and within it are operated, most of them independently, 315 electric utilities, 18 railroads, and 96,000 industrial plants. The superpower zone is the finishing shop of American industry.

Unlike the Pacific coast region, where water-power abounds and industry is relatively small, the superpower zone has relatively small hydroelectric resources and maximum industrial-power requirements. When the increases during the last 10 years are projected to 1930, even at a lower rate, the total energy requirement of the zone in that year is found to be 31,000,000 kw-hr., of which about 21 per cent can be supplied from water-power.

Fortunately some of the best coal deposits in the country lie near this great industrial territory, and a prime economic purpose should be so to conjoin the hydroelectric supply of power to the steam-electric supply as to produce a maximum of energy for a minimum investment of capital and a minimum operating expense, and at the same time to conserve the rapidly disappearing cheap fuels of the Appalachian coal fields.

The superpower system here recommended comprehends a plan of power production that includes the generation of electricity by steam at tidewater and on inland waters where a sufficient quantity of condensing water can be obtained, and also the utilization of all hydroelectric power that may be economically obtainable from rivers within the zone or within transmission distance of it. The electric power so generated will be coordinated through a system of interconnected transmission lines, the potentials of which will be on the order of 220,000 and 110,000 volts.

Under the present independent operation of the electric utilities and the manufacturing industries in the superpower zone the existing power plants are numerous and small. The average capacity of the 558 electric-utility plants now in operation in the zone is 7900 kw., and that of the steam-electric plants 10,000 kw., while the hydroelectric plants average only 2800 kw. Out of 96,000 industrial establishments in the superpower zone 76,000 use power, and each of these isolated plants averages about 350 hp. Under the superpower system, by contrast, the number of power stations required to supply the entire zone in 1930 will be only 273, of which 218 will belong to the existing electric utilities. The capacity of the base-load steam plants will range from 60,000 to 300,000 kw. In none of these plants will there be installed a turbo generator having a capacity of less than 30,000 kw.

The new power stations and load centers will be so located with reference to the existing electric-utility plants that are to be incorporated in the system as to insure the maximum aggregate economy in power generation and transmission. A prime object to be attained in the superpower plan is the maximum economic utilization of existing generation and transmission equipment. In the early stages, while the superpower system is taking form, existing electric-utility capacity will predominate. Indeed, in 1930, as much as 31 per cent of the total superpower capacity will be contained in plants belonging to the present electric-utility companies.

INDUSTRY IN THE SUPERPOWER ZONE

The maximum economical use of purchased power in the superpower zone in 1919 would have produced a saving in coal amounting to 13,502,100 tons. To determine this saving it was necessary to ascertain the coal-burning rates of the industries that developed their own power as against the rates that would have been required to supply them power from central stations.

Out of 96,000 individual establishments in the zone 76,000 used power. The industries analyzed included manufacturing establishments, laundries, mines, and quarries, and government manufacturing institutions. These industries are listed under 17 main groups, which are so subdivided as to form 53 classes.

The fundamental information required for the determination of the mechanical power-supply equipment and fuel used by all the industries necessarily had to be procured from the Bureau of the Census, if for no other reason because time would not have permitted its independent compilation. This information is presented in the tables of the appendix variously—by character of power supply, by industrial subgroups, by county, and by size of plant. The presentation of the data in this form appears not only to be essential to this analysis, but should be of great interest and value to all engineers who are interested in industrial power and heat.

The analysis showed that in 1919 the equivalent of 9,311,440,000 kw-hr. was developed by prime movers operated by the industries themselves and that 3,338,800,000 kw-hr. was purchased. It further shows that it would have been economical to shut down 4,008,200 hp. of prime movers and purchase energy to the amount of 5,623,800,000 kw-hr., which would have made a total of 8,962,600,000 kw-hr. purchased in 1919. The saving in coal thus effected would have been 13,502,100 tons—71 per cent of the coal used by the industries for producing power, or 25 per cent of all the coal used by the industries. In making the industrial power analysis care has been taken not to invade the field of what might be termed by-product power; that is, power produced by the industries from coal that would have been burned, anyway, for heat and in industrial processes. The saving determined is that made on coal burned for power and chargeable to the supply of power. It has been difficult to separate one class of coal burning from the other, yet after consultation with many authorities a separation has been made.

THE POWER REQUIREMENT OF INDUSTRY

In general it has been found that industrial establishments which require 500 hp. or less can economically purchase energy. Only those that need more than 500 hp. and that have special requirements for heat can generate their own power economically, and even these should have central-station connections to take up irregularities of load. The efficiency of power production by isolated industrial plants is precluded from any considerable improvement by their necessarily small average capacity.

A careful study of the power requirement for industrial establishments in the superpower zone has been made, and has shown that by 1930 an annual saving of $190,000,000 can be made to the industries themselves above the fixed charges against an investment of $185,000,000 for the motor equipment necessary to utilize the power.

Such a result will not of course be effected by any mysterious magical act of a superpower system. Indeed, many of the electric utilities have already been in a position to offer large savings to the industrial plants within reach of their distribution circuits.

In this study of the economical generation and distribution of power throughout the superpower zone full allowance has been made for the capital required to place regional plants in action, with their generating and transmission equipment connected with the distribution systems of the existing electric utilities, so as to reach every industrial worker in the zone. It is therefore hoped that this presentation of the saving that can be made may prove worthy of consideration by the executive officials of the industrial establishments in the zone.

THE LABOR SUMMARY

Statistics and News from Industry

Employment, Industrial *331.1*

Employment Increased in October Slightly Over 1 Per Cent.

OCTOBER witnessed a further gain in industrial employment, the outstanding feature being a marked increase in the number of workers engaged in the basic industries, iron products, and railroads.

The figures of the U. S. Employment Service show that the 1428 concerns, who normally each employ 500 or more, increased the number of workers on their pay-roll from 1,544,529 to 1,560,155; a gain of 15,626 or slightly over 1 per cent. The detailed figures for the month compiled by the Employment Service are given in somewhat condensed form in Table 1, while Fig. 1 shows the trend of employment since July in each of the 14 industrial groups.

A brief summary of employment conditions about the various sections of the country follows:

New England District (Me., N. H., Vt., Mass., R. I., and Conn.). Business in New England has shown a decided improvement during the past month. Textiles generally are making an excellent showing, with wool nearly normal. Shoes and leather, however, are having a seasonal easing off. Rough and finished stone is also quiet, but lumber specials are showing some strength. Transportation and railroad equipment, paper, and rubber have made gains.

Middle Atlantic District (N. Y., N. J., and Pa.). Reports from this district indicates slow but sure improvement in general business conditions. Building is quite active in all parts. Committees are being formed in many sections to cope with the unemployment problem as suggested by the Washington Unemployment Conference, and many States and cities are going ahead with public works of all kinds with a view to providing employment for as many as possible. In New York State very little change has been evident in business conditions during the last month, but throughout New Jersey it is reported that slightly improved business conditions are noticeable. Reports from Pennsylvania indicate that the steel and iron industries continue to show gradual improvement, although not as marked as a month ago, and that coal mining production is increasing.

East North Central District (Ohio, Ind., Ill., Mich., and Wis.). Present employment activities in this district appear to indicate more than the dawn of better times. In Illinois employment conditions are growing better, and many of the large corporations, particularly the public utilities, are engaged in expanding or remodeling their plants. In Ohio tin-plate mills in several sections have reopened, and work on 30 miles of paved roads in one county is under way. Indiana manufacturers are optimistic and confident that the near future will see a decided improvement in buying, while in Michigan general conditions among the industries appear to be somewhat healthier than in previous months during the summer. In Wisconsin much building and public improvement is going on, stimulated somewhat by the fact that the cities are urging continual and increased building as a part of their program for relief of the unemployed. Wood-working industries of Wisconsin also show an increased production, working about 9 to 10 hr., with orders which will keep them busy until the first of the year.

West North Central District (Minn., Iowa., Mo., N. D., S. D., Neb., and Kan.). There was a decided improvement throughout this district during October. Improvement is most noticeable in retail trades, railroad repair shops, building trades, and textile lines. Unemployment has received a large measure of attention during the month, and in the unskilled groups it is apparently increasing, which is a customary seasonal condition. It is noted, however, that many localities having a large measure of unemployment are unable to secure men for corn husking and in some instances farmers decline to accept men for this work unless they are experienced, as the element of skill makes a poor worker too expensive even at a minimum wage.

TABLE 1. THE TREND OF EMPLOYMENT IN 1428 AMERICAN INDUSTRIES DURING OCTOBER, 1921
(Compiled by the U. S. Employment Service, U. S. Dept. of Labor)

Industrial Group	Number on Pay-Roll		Net Change Sept. to Oct.
	Sept. 30	Oct. 31	
1. Food and kindred products	138,086	139,082	+996
2. Textiles and their products	267,661	269,567	+1,906
3. Iron and steel and their products	314,093	330,317	+16,224
4. Lumber and its manufacture	22,309	22,765	+456
5. Leather and its finished products	54,593	55,440	+847
6. Paper and printing	47,686	47,655	—31
7. Liquor and beverages	965	1,385	+420
8. Chemicals and allied products	71,673	73,520	+1,847
9. Stone, clay, and glass products	12,782	14,389	+1,607
10. Metal and metal products other than steel and iron	76,394	78,050	+1,656
11. Tobacco manufacturers	31,633	32,395	+762
12. Vehicles for land transportation	174,131	169,248	—4,883
13. Railroad repair shops	65,347	69,398	+405
14. Miscellaneous industries	267,176	256,944	+10,232
Total	1,544,529	1,560,155	+15,626

South Atlantic District (Del., Md., D. C., Va., W. Va., N. C., S. C., Ga., and Fla.). Employment conditions have continued to improve throughout the district for the past month. Textile mills show a 1½ per cent increase in employment. Mill operators generally are encouraged as to the outlook for business the next few months. In Georgia, North Carolina, South Carolina, and Florida 120 lumber and products plants employing 11,849, show a decrease in employment of 284. Some sections show fairly active demand for their products while others are falling off somewhat. In Virginia 36 coal operators show a total employment on October 15, of 7419 with an increase of 106. An increasing demand for industrial coke is a further indication of the improvement in the steel and iron industry.

East South Central District (Ky., Tenn., Ala., and Miss.). There has been a slight gain in employment in this district. Some improvement is noted in lumber, yellow pine mills having increased production so as to reach about 80 per cent. Coal mining continues to show about 40 per cent of normal production. Some increase in coke production is indicated, due to increase in steel and iron products. Iron and steel show slight improvement as well as metal trade.

West South Central District (Ark., La., Okla., and Tex.). Business conditions throughout this district have shown a very noticeable improvement during the past month. The advance in the price of crude oil has done much to create a better feeling and stimulate activities. Pine lumber continues to improve with a demand for better grade stock and a number of mills which were closed down have resumed operations. Railroad repair shops and packing houses have increased their forces and oil field operations have expanded. Building trades are more active. Metal trades continue quiet. Housing shortage still

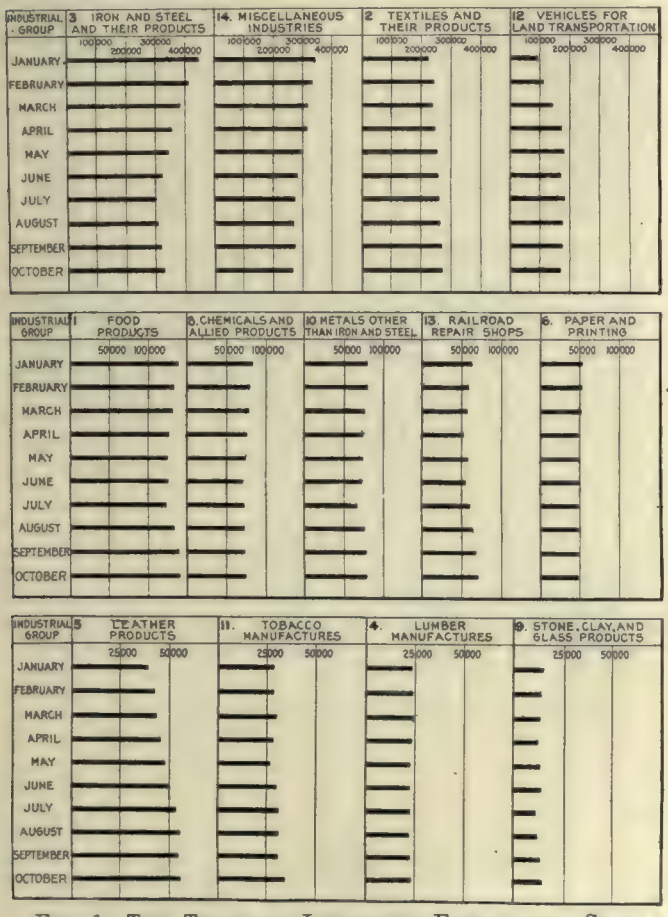

FIG. 1 THE TREND OF INDUSTRIAL EMPLOYMENT SINCE JANUARY, 1921

exists but conditions are improving gradually. The wholesale and retail trade situation is good with the unit volume of business exceeding that of last year in many places.

Mountain District (Mont., Idaho, Wyo., Colo., N. M., Utah, Ariz., and Nev.). Although a downward trend is noticeable in general employment due to the decline in agricultural activities, no marked change is as yet apparent. In several sections substantial gains are noted in coal mining districts, while, on the other hand, metal mining centers show virtually no improvement. Building operations have somewhat increased. Public improvement work is generally sluggish notwithstanding increased activity reported from various points. Railroad operations show a slight upward trend, particularly in regard to right-of-way maintenance work and repairs. But little betterment has taken place in miscellaneous manufacturing lines, although the outlook is considered more encouraging.

Pacific District (Wash., Ore., and Cal.) Seasonal activities, responsible for so much temporary employment, are now drawing to a close, throwing a large number of workers on an already overcrowded market. Lumber has shown some improvement, but is yet far below normal; iron and steel are inactive, and shipbuilding is at a standstill. Building industry is active and shows improvement over last month.

Industrial Earnings Decline in October

INDUSTRIAL earnings continued to decline during October according to figures gathered by the U. S. Bureau of Labor Statistics. A condensed presentation of the figures compiled by the Bureau is given in Table 2, the average earnings reported for the two months being obtained by dividing the total amount of the payroll for any industy by the total number of employees on the payroll in the industry during the month.

TABLE 2. AVERAGE EARNING IN SELECTED INDUSTRIES DURING AUGUST AND SEPTEMBER, 1921

(Based on Figures Compiled by the U. S. Bureau of Labor Statistics

INDUSTRY	PERIOD OF PAY-ROLL	AVERAGE EARNINGS DURING	
		Sept. 1921	Oct. 1921
Iron and steel	½ mo.	$38.80	$42.00
Automobiles	1 wk.	31.40	29.20
Car-building and repairing	½ mo.	58.50	60.50
Cotton manufacturing	1 wk.	16.90	15.60
Cotton finishing	"	22.00	21.00
Hosiery and underwear	"	16.40	17.60
Woolens	"	22.40	20.05
Silk	2 wks.	41.70	39.80
Men's clothing	1 wk.	31.60	27.00
Leather	"	22.60	21.70
Boots and shoes	"	22.80	21.80
Paper making	"	23.60	24.20
Cigar manufacturing	"	19.00	18.10

As shown by the table average earnings decreased in all industries except iron and steel, car building and repairing, hosiery and underwear, and paper making, the greatest decrease being in men's clothing, where a loss of about 16 per cent occurred. The workers in the automobile industry suffer the next greatest reduction with a loss in earnings of approximately 10 per cent.

A few abstracts of the Bureau reports on wage changes during the month of October follows:

Iron and Steel. A decrease of 20 per cent was reported by two mills, which affected 70 per cent of the men in the first mill and 65 per cent of the men in the second mill. Decreases ranging from 12 to 18 per cent were made to the entire force of 11 establishments. Increased production, caused by resumption of work, is reported however for the iron and steel industry, and the per capita earnings for October are consequently 8.5 per cent higher than those for September.

Automobiles. A decrease of 10 per cent in wage rates was made to all employees in one establishment, while in another the piece workers, or 34 per cent of the employees, were reduced 5 per cent in wages, while the hourly men, or 22 per cent of the employees, were reduced approximately 7 per cent in wages. On account of decreased production, many establishments are working on a short-week schedule, and the per capita earnings show a decrease of 7.2 per cent when compared with September.

Textile Industries. Although a greater number of persons were employed in cotton manufacturing during October the working time was reduced, and the per capita earnings are therefore 8.4 per cent less than for September. In cotton finishing the per capita earnings for October show a decrease of 4.5 per cent over September, while in hosiery and underwear employment conditions have improved and the per capita earnings are 3.9 per cent higher than in September. In woolens a decrease of 9 per cent in per capita earnings is noted, but in silks an

increase of 2.7 per cent took place. In the men's ready-made clothing industry part-time employment was reported, due to the seasonal decline in trade and the per capita earnings therefore show a decrease of 14.5 per cent when September and October payrolls are compared.

Cost of Living *331.2*

No Change in Cost of Living

THE cost of living in the United States during October was practically the same as in September, according to the figures gathered by the National Industrial Conference Board. The details of the Board's findings are given in Table 3, while Fig. 2 shows the changes which have taken place in the cost of living since January, 1915. Living costs it will be noted are still approximately 64 per cent above pre-war levels.

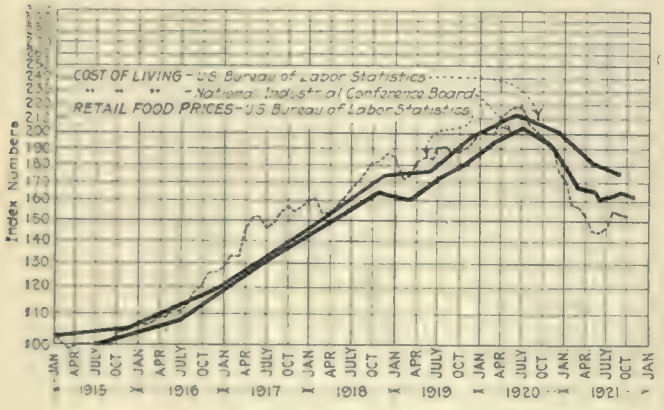
COST OF LIVING - U.S. Bureau of Labor Statistics
" " " - National Industrial Conference Board
RETAIL FOOD PRICES - U.S. Bureau of Labor Statistics
Index Numbers
JAN APR JULY OCT
1915 1916 1917 1918 1919 1920 1921

FIG. 2 THE TREND OF THE COST OF LIVING

But slight changes also took place in wholesale prices, the U. S. Bureau of Labor Statistics index number for all commodities moving from but 150 to 152. Table 4 gives the index numbers for the various commodity groups, while Fig. 3 shows the trend of all wholesale prices since January, 1915.

TABLE 3. PER CENT CHANGES IN THE COST OF LIVING IN THE UNITED STATES FROM OCTOBER TO NOVEMBER, 1921

(Compiled by the National Industrial Conference Board)

ITEM	RELATIVE IMPORTANCE IN FAMILY BUDGET PER CENT	PER CENT INCREASE ABOVE AVERAGE PRICES IN JULY, 1914 AND		PER CENT CHANGE OCTOBER TO NOVEMBER
		October 1921	November 1921	
Food	43.1	53*	53*	No change
Shelter	17.7	69	69	No change
Clothing	13.2	60	60	No change
Fuel and light	5.6	79	80	0.6 increase
(Fuel)	(3.7)	(92)	(93)	(0.5 increase)
(Light)	(1.9)	(55)	(55)	(No change)
Sundries	20.4	80	80	No change
Weighted average of all items	100.0	63.7	63.8	0.06 increase

* Food price figures are for the 15th of the preceding month, from the United States Bureau of Labor Statistics.

TABLE 4. INDEX NUMBERS OF WHOLESALE PRICES, BY GROUPS OF COMMODITIES, FOR SEPTEMBER AND OCTOBER, 1921

(Compiled by the United States Bureau of Labor Statistics Base Year 1913 = 100)

COMMODITY GROUP	1921		1920
	September	October	October
Farm products	122	119	182
Food, etc.	146	142	204
Cloths and clothing	187	190	257
Fuel and lighting	178	182	282
Metals and metal products	120	121	184
Building materials	193	192	313
Chemicals and drugs	162	162	216
House-furnishing goods	223	218	371
Miscellaneous	146	145	229
All commodities	152	150	225

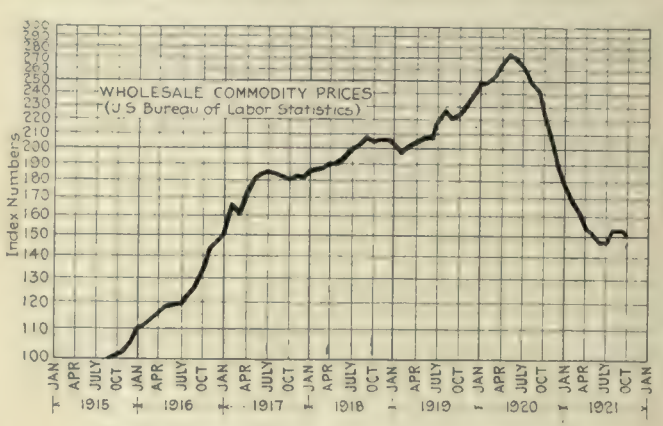
WHOLESALE COMMODITY PRICES
(U.S. Bureau of Labor Statistics)
Index Numbers
JAN APR JULY OCT
1915 1916 1917 1918 1919 1920 1921

FIG. 3 THE TREND OF WHOLESALE PRICES

Index Numbers *338(026)*

Industrial Index Numbers

IN the October issue MANAGEMENT ENGINEERING began the publication of a series of tables and charts showing trends in industrial movements since January, 1920, and the charts which appear on the following page bring this information up-to-date. As before they are based upon reports issued by the Department of Commerce under the title of "The Survey of Current Business." The data issued by the Bureau are gathered from many sources, such as the various bureaus of the Government, trade associations, trade journals, etc., the value of the compilation being in the fact that there is thus brought together in one place statistics formerly widely scattered. Limitations of space will not permit of a detailed analysis of charts presented, but attention is directed towards the fact that in the majority of cases the relative index numbers are computed on a basis of the average of the year 1913 as equal to 100. In some instances, however, the basic statistical data do not go back to pre-war years, and in such cases averages for the year 1919 have been employed as a base. In still a few other instances special base years have been employed. In all cases, however, the base year used is clearly indicated.

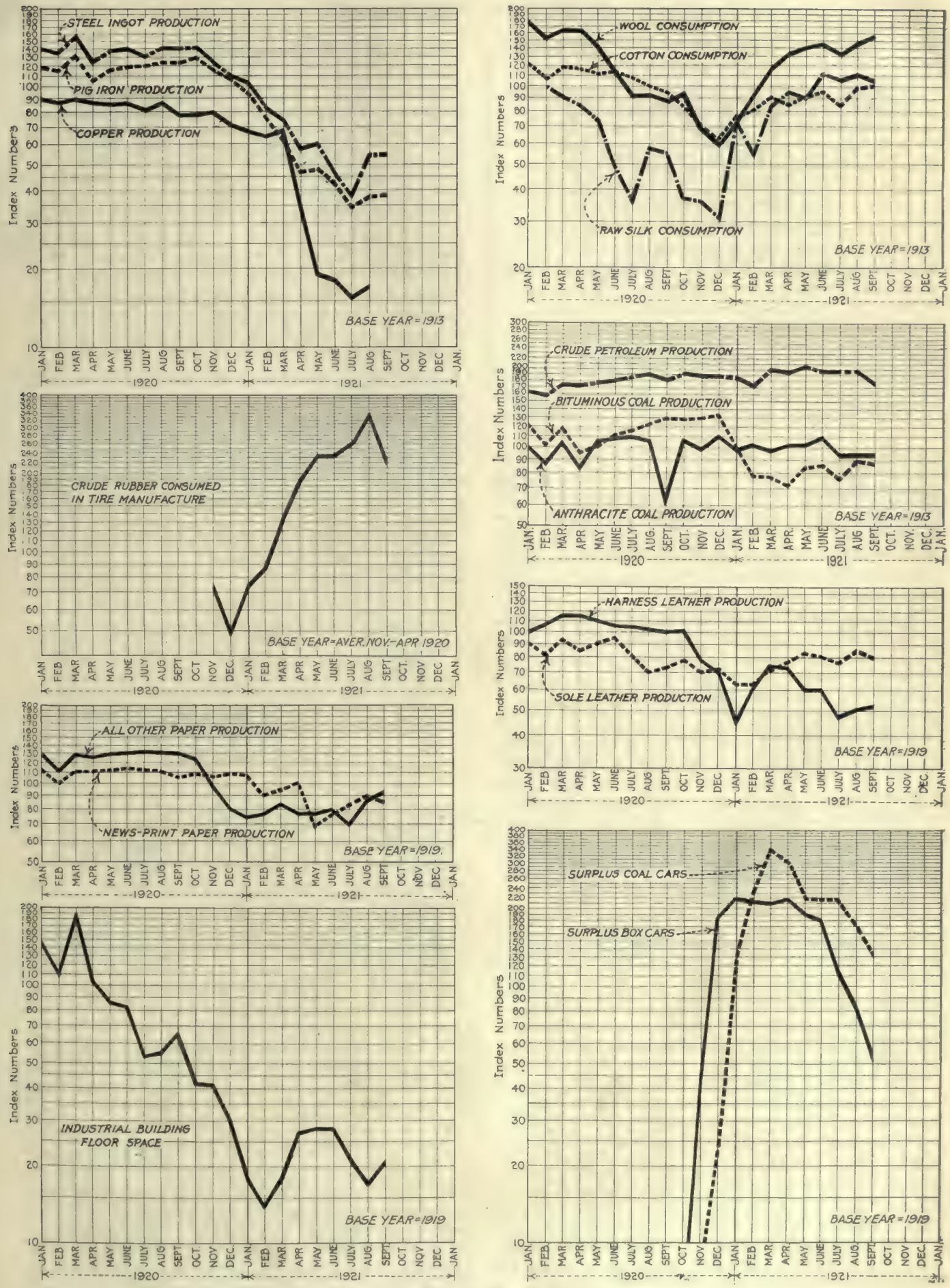

FIG. 3 TRENDS IN INDUSTRY SINCE JANUARY, 1920

MANAGEMENT ENGINEERING

THE JOURNAL OF PRODUCTION

L. P. ALFORD, *Editor*
E. W. TREE, *Associate Editor*

Published Monthly by The Ronald Press Company, 20 Vesey Street, New York

Why We Can Disarm

THOUGH peoples have fought wars throughout all the centuries, from the beginning of recorded history until today, no nation has disarmed unless it was vanquished, unless it was forced by will of a victor or by stern economic necessity. But today the great allied nations of the world are meeting in conference to plan for voluntary disarmament. The principle has already been accepted.

What has brought this great change in regard to the necessity of possessing equipment for making war? Do we not find the answer in the shifting of public confidence? During the past war we began to understand that a nation's real strength did not lie in millions of trained solders, in huge battle fleets ready for action, in armories filled with guns and munitions, but rather in the ability to produce these things when they were needed. By this thought confidence has been transferred. Reliance is no longer placed upon a huge store of implements of warfare but rather upon the morale of the people and the industries and human skill that can produce whatever is needed in the face of a great emergency.

The record of the United States in producing war material clearly proves the sound basis of fact for this changed point of view, and because of this we can now safely accept the principle of disarmament and consider just how far we are justified as a nation in lessening our equipment for war. All this reflects credit upon the engineer and industrial executive. When disarmament comes it can truly be considered as another great triumph of modern industry.

It is true no one must believe that disarmament can ever be complete while there are nations whose temper is uncertain. So long as these exist, just so long must other nations possess the ability to exercise a police power. And more than this, when the confidence of the people has been shifted so that reliance is placed upon industry and engineering, we must make sure that at all times there is a sufficient producing capacity to turn out whatever may be required in case another war must be fought, however unwillingly we may enter into it. But the cost to the nation of transforming private industries making peace products into war industries making munitions will be a mere trifle compared with the expense of building war material year after year, storing and protecting it against deterioration, and keeping in existence an organization for its care. This great release from excessive expenditures for possible war is the great boon that will come to the world through partial disarmament.

Once this requirement of organized manufacturing capacity has been fulfilled, the production of war material should become a government monopoly to remove forever any private interest or profit in arms manufacture. Whatever expenditure may be necessary in connection with private plants to keep them in readiness to produce war material should be borne as a government expense.

A portion of the vast sum that will be released through partial disarmament should be spent on our schools for the improvement of educational facilities. In the hour of crisis we will not only need an industry which can be transformed to a war basis, but we will need millions of young men so educated that they can be developed into a fighting army with a minimum of training.

These safeguards rest, the one upon management in engineering and in industry, the other upon management in education.

"Put in a little more metal," and "make it so strong it can't break," was good advice when cast-iron was cheap. But many a designer and pattern-maker is now busily at work taking out the unnecessary metal that the previous overgenerous policy put in.

The Significance of Coal Wastage

THE report made to the Department of the Interior by W. S. Murray and others in regard to a superpower system for the region between Boston and Washington is in reality a second Waste Report. In the introduction Mr. Murray says that his reason for this investigation was the unnecessary waste of money, labor, and material incident to the present form of power production.

In regard to industry in the superpower zone an analysis in the report shows that during 1919 it would have been economical to have shut down 4,008,200 hp. of prime movers and purchase the energy which they developed. The saving in coal thus effected would have been 13,502,100 tons. This amount is 25 per cent of all the coal used by industries in the zone.

This is a tremendous wastage of fuel—material—but in itself is far from being the whole story. To grasp its true significance we must think of the waste of the labor of the miners who dug this coal, of the mining equipment and its operators who handled it to freight cars, of the railroad equipment and organization that transported it, of the handling machinery and men who unloaded it to storage and later handled it to the boiler rooms, of the boiler-room equipment and attend-

ants where it was burned, and the use of machinery and labor of men who disposed of the ashes. That is, not only was there a wastage of more than thirteen millions tons of coal in the superpower area, but there was the profitless utilization of a tremendous amount of expensive machinery and thousands of men who operated it from the mine to the ash heap.

But even this picture of the wastage of fuel, human energy and time is far from complete. The superpower zone is but a small part of the United States, and when figures are presented for the entire country the totals will be much greater. But if the Superpower Survey Report did nothing but focus attention upon the wastage of fuel which is avoidable by the use of apparatus and method of operation already well known, it would have justified all of the efforts and expense of its preparation.

It is refreshing to have a few facts instead of general opinions as to how far employment management has been curtailed or abandoned in industry. In the Manufacturers' Association of Connecticut there are approximately 800 member industrial plants. H. J. Smith, industrial secretary, has reported the results of a recent survey of seven of the State's largest industrial communities. This indicates that in one city one employment manager was temporarily released for a period of two months, due to the suspension of plant operation. In the same city another was permanently released for the reason that the plant had ceased operating and was reported as going out of business altogether. In a second several employment managers were released on account of business conditions. The employment function, however, was assumed in each plant by the superintendent. Although some curtailment has taken place in many employment departments, in others the functions of the employment manager have been enlarged by adding certain industrial relations work which had previously been handled by other departments.

To sum up, the changes and modifications are only reasonable considering the condition of business. As a whole it may be safely said that the employment function is on a permanent basis in Connecticut industry.

The Unknown Server

ALL the allied world has united in awarding the highest honors and extending the greatest homage to the unknown warrior of Great Britain, the *poilu inconnu* of France, the nameless hero of Italy, and the unknown soldier of America.

In this tribute there has been universal veneration for valorous deeds. In a way that will always be remembered the virtue and sacrifice of the common soldier have been glorified by his people.

May we not use this outburst of feeling to lead us to some recognition of the multitude of unknown men and women who have served the people in everyday tasks? To whom are we indebted for the great comforts that we enjoy today, for our well-being, for the basis of our civilization? Here and there we can name one who has made a great discovery or a revolutionary invention. It is as easy to honor such a one as it is to honor a great general or a leader of the people, but just as the common and unknown soldiers are behind the general and supply him with the means for winning victories, so there are unknown workers behind the inventors and discoverers in engineering and in industry.

The iron and steel which means so much to us today has been made possible through the work of the men who first smelted iron ore, made iron, produced steel and tempered it. But we cannot name them. The fabrics for our clothing are ready for our use in such profusion and beauty because some woman first pulled the fibers from the cotton boll and twisted them into yarn, or tried to spin the wool of a sheep or goat or the hair of a camel, or wove the fibers that remained when the woody part of a flax stalk had rotted away—yet she is unknown.

Is not the unknown server entitled to the same honors as the unknown soldier? May we not some day glorify the work of a multitude of nameless men and women who lived useful lives, contributed to the sum total of human experience, and did work upon which others, in a climax of discovery, built to contribute more to our well-being than the winning of battles or the ending of campaigns?

From that day when this tribute is paid it will be easier for everyone of us to do our daily tasks.

A young engineer had been hired to discover waste and to make savings. He had been around the shop for a number of weeks without doing much. One day he happened to enter the office and saw a group of employees, young men and women, with heads close together over a desk, doing something with great animation. The engineer watched long enough to make up his mind that they were playing some game, and from the exclamations he judged its name was "Put and Take."

Here was a chance to cut down waste, to make a showing. So he wrote a report estimating the loss to the company because the people in the office were playing "Put and Take" instead of working.

For several days he tried to see the general manager and present this report in person. He was unsuccessful. At length he determined that this waste should go on no longer, and went to the general manager's office, only to discover that the board of directors was holding a meeting. He insisted to the manager's secretary that the report must be presented then and there, and finally the young lady consented to break into the deliberations of the board. As she opened the door of the general manager's room the young engineer glanced over her shoulder to see a group of grey heads close together above a mahogany table, and to hear the voice of the president boom out, "All put!"

THE TIME-STUDY CONTROVERSY—A REPLY

By FRANK B. GILBRETH

Consulting Engineer

WE desire to call attention to what we believe to be misstatements in your editorial on page 188 of the September issue of MANAGEMENT ENGINEERING.

1. Your title "The Time-Study Controversy" leaves out an important part of the controversy, namely, "motion study." This is not merely a "time-study controversy."

2. Your statement in Paragraph 1, that "the majority of the points raised still seem to be at issue, because of the absence of facts and quantitative data," seems to be unwarranted, because: (*a*) The numerous notes and references quoted, in addition to the paper itself, give all the facts and quantitative data needed to prove the case, and (*b*) The Managing Director of the Taylor Society stated that:

> The proponents of the stop-watch, on the other hand, seem to concede what is claimed for micromotion technique with regard to the above characteristics (a simple, matter-of-fact concession, however, unaccompanied by any statement of their valuation of what is conceded) and focus their discussion on the determination of standard times and standard rates for current use. The definite point which remains at issue, therefore, seems to be whether the stop-watch technique is so "unscientific" as to be unsuitable for the determination of standard times and standard rates as a basis for current wage contracts.

Therfore, they have already conceded all points but one of our indictment.

3. In Paragraph 2, you state "there seems to run a lack of appreciation of perspective." It must be remembered that the micromotion method records the one best way to do work, and records and transfers the skill and education of the worker and his foremen, not merely the time that it takes a certain worker to do work under the existing conditions, which cannot possibly be recorded with a stop-watch.

Examine any stop-watch time-study in any book now published, and you will see exactly what we mean. The time element of any one individual worker's work is perhaps the least important of any of the features of the motion study. The recording of the one best way to do work is the principal feature and the most valuable.

4. We are unable to see your viewpoint or reason for ignoring the fact that the micromotion method does not entail taking pictures any oftener than is necessary to obtain the desired facts. "Boring and turning 16-in. gun forgings" is not a stranger to us. On such work it is sometimes advisable to take pictures on some parts of the operation not oftener than, say, once in 15 min. or once per hour—perhaps even less frequently.

It is not to be supposed that engineers of more than a third of a century's continuous experience in motion study in managing large numbers of men will continue to take pictures that have no value. Obviously, when there are no changes in the surrounding conditions and no motions to record, it would be silly or subnormal to take pictures. In any case, we have again and again emphasized that the *times* are of little importance without *accurate records* of the surrounding conditions and the methods used. These the stop-watch cannot give, and neither can the 8-day grandfather's clock. Yet these are fundamental requirements for the transference of skill most efficiently in the one best way.

5. In Paragraph 4, you state "The editor of the matter appearing in the *Bulletin* asks for further evidence, particularly in regard to actual times and costs." To this we reply that immediately upon reading his request we called upon him and informed him that we were ready to do our part. As evidence of this we delivered a second indictment before the New York Section of the Taylor Society, September 15, 1921, and at that time stated:

> We are perfectly willing to present all the additional facts that may be required. We have all the material ready at the present time. We have among our files and data over a million lantern slide negatives from which to select to exhibit for proof of these facts. We also have much stop-watch time-study available. We also have micromotion study and stop-watch data that were made simultaneously. When the comparisons are made, the proof is certain that the only reasons for the continuation of the inaccurate non-recording stop-watch are the ignorance of the employers of the inadequacy and wastefulness of the stop-watch methods and results, and the lack of knowledge of the stop-watch proponents of the technique of motion study, micromotion study, and the chronocyclegraph processes for obtaining better methods. We are willing also to review stop-watch time-study in detail, and we are willing to make new studies in competition with the stop-watch time-study process, if the stop-watch proponents are not willing to use their data of the past to prove their case.

This offer we repeated later to the Director of the Taylor Society and it stands open at the present time.

6. Regarding your Paragraph 5, where you question the relative accuracy of the stop-watch and the micromotion recording devices, we think this is sufficiently answered in our paper and discussion. However, we will state that accuracy of time without records of method can hardly be considered as competing with photographed time with the complete record of all motions and surrounding conditions.

Regarding the statement "even the application of a microscope to the films themselves cannot possibly show the condition of repair of the machine, the correct shapes and settings of the tools, nor the spindle revolutions and the feeds of the machine observed"—we would say, if anyone who fails to understand or who doubts these possibilities will call at our laboratory, we will show him that we can record all desired information much better than has ever been possible with the stop-watch method. What is more, we would like to emphasize that we have always from the start, and without exception, done such recording.

We desire to state emphatically that we can do much more than photograph "the correct shapes and setting of the tool," and "the spindle revolutions and the feeds of the machine," for we can record on the photographic micromotion study films the shape of the tools and the chemical composition of the high-speed steel of which they are made. We can also show plainly and beyond question the skill and past experience of the observed worker. This also we will be pleased to show anyone who will call at our laboratory (by appointment).

7. We can scarcely answer the question in Paragraph 6 as to the comparative degree of skill needed "to interpret stop-watch observations on the one hand, and the motion-picture films on the other." We cannot conceive how stop-watch observations of motions and skill *can be interpreted* when there is no record whatever of motions or skill. The micromotion records are interpreted by the simultaneous motion cycle charts which were referred to in the *Bulletin*.

8. The question in Paragraph 7 of the relative cost of stop-watch time-study and of micromoton study is already answered in the *Bulletin*. We will say again, however, that, all things considered, the micromotion method is the cheaper because it will pay for itself from the first. Furthermore, we will gladly take micromotion study records gratis, and furnish a positive print, free, of the best man obtainable doing the work in the one best way to do work. His priceless skill is worth much more than the insignificant cost of the film. This surely answers the "How much?" question.

Regarding the criticism in Paragraphs 8, 9, and 10 of our statistical quotations, we would suggest that this point be left to any experts in statistics. The criticism contained in these paragraphs was taken by us to such statistical experts and all those consulted agreed with us in every particular. Moreover, we desire to state that we are entirely satisfied with our wording exactly as you have quoted it. We might add, however, that almost invariably we have found that the "lowest time," which is frequently discarded as being "abnormal" under the stop-watch method, is often found to be nearer correct than the "average" of the many observed stop-watch times. There are always other factors than the personal errors of the observer, for neither the method nor the effort of the worker is ever twice exactly alike. Therefore, "first year statistics" do not apply.

We believe that, in the light of the above facts, if our indictment of Stop-Watch Time-Study is reread it will be seen that stop-watch time-study is fully as "inaccurate as the indicters of stop-watch time-study would lead us generally to believe."

BOOK REVIEWS

Labor. England *331(42)*

INDUSTRIAL PROBLEMS AND DISPUTES

By Lord Askwith

Published by Harcourt, Brace and Company, New York

REVIEWED BY JOHN CALDER

Manager of Industrial Relations, Swift and Company, Chicago

PRACTICALLY all the recent literature by American and British authors on labor conditons in England has dealt solely with war conditons and war practices. The present book, however, gives an inside view of the history of government conciliation in British industry from the passing of the Conciliation Act in 1896 down to the present time. Dealing with the 18 years preceding the war from an intimate standpoint it affords a general view of the whole situation, and it is notable for the slight expectations which the author has that Whitley Councils will do much to solve the problem of industrial friction.

Prior to 1896 the good offices of the Board of Trade, which then combined departments similar to our Labor and Commerce Bureaus, were available in disputes without statutory powers. The act of 1896 was purely permissive without penalties or power to compel evidence. It was practically a statutory advertisement of the willingness of the Board of Trade to intervene in disputes and merely justified the Board in initiating inquiry. Hence, the way in which the Act was responded to depended upon the kind of men used in intervention rather than on any powers conveyed by the Act. Yet both without and with this weak instrument Lord Askwith, then Mr. George K. Askwith, a King's Counsel practicing at the Bar, and other men especially selected were able to accomplish remarkable work in composing important disputes, and as they faced again and again over a period of twenty years the same industries, practically solidly unionized, they became more expert and their rulings more acceptable.

In 1907 the present Prime Minister, Mr. Lloyd George, then a Cabinet Minister and head of the Board of Trade, invited Mr. Askwith to join that department as a permanent member, which the latter did for a period of 12 years, retiring a few months after the armistice.

In this book, after preliminary chapters dealing with the supreme place which the training of the young entering industry holds in future industrial peace, the author proceeds chronologically according to the order of the great strikes in Britain. He begins with the dock workers' strike in 1889, a revolt of the lowest paid casual labor; then follow accounts of the strikes of the railroads, the miners, the seamen, the textile trades, and the engineers. Some of these strikes were repeated more than once in the cycle of economic friction. The war, of course, greatly complicated matters through agreements to cease strikes and adjudicate all issues, agreements which labor did not keep in England, any more than it did in America, pleading as an excuse the prevalence of profiteers.

The painstaking and successful work of skilled conciliation and arbitration, based on fact and principle, gave way with the English as it did with us to a multitude of inconsistent and opportunist decisions in which the urgency of war requirements and political bias were the outstanding features. The revision of these decisions at a time of abnormal dulness is now proceeding with dissatisfaction all around.

The author of this book does not conceal his dislike for the reckless liberality and total lack of principle shown by the amateur conciliators who flooded government departments during the war and who were permitted to augment the work of Board of Trade experts without availing themselves of their experience. The book is full of local color and of pen portraits of

famous labor leaders, and disputes are handled with a detail that is not apt to be fully appreciated by American readers. Yet there are lessons here which we ought to take to ourselves. The author had to sit for hours listening to professional representatives of labor—which was about 75 per cent organized before the war and over 90 per cent during it—who unnecessarily spun fine theories of Socialism, Syndicalism, and Guild Socialism around their arguments. Yet he testifies that he never once found employees, themselves, with any such theories or consciousness about their case. The employees were direct, simple, and concrete about their grievances and demands and were relatively easy to handle and to guide into reasonable paths provided they were first allowed to state their case fully to one whom they regarded as impartial. The author is evidently distrustful of results obtainable from bi-partisan or tri-partisan boards, and his distrust carries weight as the testimony of British employers and British employees alike shows that the author of this book was a man of inexhaustible patience, strict impartiality, great lucidity of mind, and possessed of the necessary restraint to wait for the psychological moment before making the suggestion likely to compose the difficulties in hand.

In connection with the enormous amount of work accomplished by Lord Askwith and other Englishmen engaged in similar tasks, we have to remember that even the most distant important industrial center could be reached in a small country like Great Britain in not more than 10 hr., and the great bulk of industrial storm centers were accessible in less than 5 hr. As a result delayed settlements such as we experience because of great distances, and such as sometimes completely alter the temper of the parties meanwhile, rarely occur in England.

The author's hopes from 22 years' experience lie in the direction towards which our own forward-looking employers are headed, namely, a degree of frankness regarding the facts of a business which would have been considered revolutionary a few years ago but which by the mere force of truth would be almost certain to disarm existing prejudice. In fact, through different experiences and practices the best representatives of industry in both countries, using the scientific method, have practically arrived at the same conclusion, as the following extract will show:

> If the spirit or the ideal of joint success and the value of increased production to all concerned can be obtained in any works or undertakings, those undertakings will be the last to have to fear dictation by trade unions, because the trade unions would have no valid ground of complaint. They will also have better opportunity of settling difficulties with their own workmen without the interference of third parties or the government. They will out-distance or absorb their competitors, who will have, from self-interest, to follow suit. Any employer who sets himself to develop his business and push forward, carrying his young workmen with him by care for their valid interests, and refusing to be tied down by the level of the most obsolete or badly equipped works in the trade, is bound to find his enterprise and care leading to good results. It may be very difficult, and the hindrances may be great. The application of principle in some industries may be very hard to accomplish. The workers cannot be taught the lesson or be brought to understanding and trust in a day; but they soon know who are good employers and who are the bad. The time has passed when employers can afford to ignore the fact that, unless there is to be continued hostility between two opposing forces, they must show the worker the real objective to which the employer is working; they must consider the comfort and well-being of the worker as a human being; they must have suitable methods of listening to and redressing valid complaints, either by the workmen themselves, or by the workmen with the aid of the management; they must endeavor to ensure to all workmen a direct interest in the result of their work, and enlist their activity in mutual success; and see that the curtailment of advancement or chance of advancement to the youth does not reduce the worker to the position of a machine. A new atmosphere is required in which men can breathe more freely.

Labor. United States *331(73)*

HISTORY OF LABOUR IN THE UNITED STATES

By John R. Commons, and Associates

Publisher, The Macmillan Company, New York

REVIEWED BY JOSEPH W. ROE

Professor of Industrial Engineering, New York University

ONE of the weaknesses of industrial executives is their comparative ignorance of the broader history of the labor movement. Most of them have a vivid knowledge of it, as it touches their own experience, or possibly their own locality and industry; but few care much about what lies behind the slow-moving giant who has shouldered his way into the industrial circle.

The giant has been seldom welcome, bitterly fought, and cast out again and again only to return. Complex as human nature itself, crude, sometimes savage, seldom creative, often ignorantly reactionary, but wiser many times than he seemed, he has been the aggressive champion of those who have had few defenders. He has come to stay, and it behooves the others in the circle to know all they can about him.

The higher type of labor leader is usually better read in the history of unionism than the manager pitted against him. It is to the interest of all that this discrepancy disappear. The "History of Labour in the United States" will help to do this. It is the fourth in a series of "Contributions to American Economic History," initiated by the Carnegie Institutions of Washington. The first was the "History of Commerce" by Professor Johnson and others; the second the "History of Manufactures from 1607 to 1860" by Dr. Clark; the third the "History of Transportation to 1860" by Dr. Meyer.

The "History of Labour in the United States" was originally in the charge of Carroll D. Wright. At his death, in 1909, the work was taken up by Professor Commons. It represents immense labor on the part of its authors.

> Many of the conceptions which have had an important influence upon the course of social and political movements are of humble origin. They have not infrequently germinated in the minds of people who have appeared to their contemporaries as agitators, fanatics, extremists, and unpractical idealists. Many of the theories advanced have been crude and fallacious and have died with, or even before, their authors. Many of the reformers have failed to realize their plans. Yet this intellectual ebullition has left a certain deposit of sound ideals and practical

methods. These have had to compete with traditional convictions, with vested interests, and with existing law, and the resultant of these often antagonistic forces has determined the color and character of our social history.

The series of studies forming this book, as Professor Commons says:

. . . . deal mainly with the history of labour conditions, of labour philosophies and of labour movements, not primarily with the structure or policies of labour unions, nor with the history of individual unions, nor with the legislative movement, nor with current problems. Their field is rather the background which explains structure, policies, results, and problems.

This book, alone, will not give a full picture of the history of unionism. As its title implies, it relates only to the United States and has nothing about the rise of unionism in England or other countries. It stops at 1896, for there is only one brief chapter on the developments since that date. But inside its chosen field—and that is a wide one—it will be of great and permanent value.

To one who follows this book the origins of the cardinal doctrines of unionism become clear. Most of them are reactions from very real abuses in the past. Many of the conditions of the Industrial Revolution in England were present in the early expansion of industry in the United States; but manhood suffrage, the greater mobility and independence of the working classes, the absence of great land holdings, and the existence of a frontier and free land in the West all served to mitigate their severity. There remained, however, the problems of low wages, rising prices, convict labor, long working hours, child labor, imprisonment for debt, and the need of popular education, some of them more acute than would seem credible today. These were amply sufficient to account for the growth of unionism in America.

It is illuminating to follow the rise and decline of unionism with the periods of prosperity and depression in general business. In periods of rising prices when the cost of living outleaps the rise of wages, when business prospers and labor is in demand, there is growth of unionism with aggressive strikes and class struggle. In the periods of falling prices, business depression, and unemployment which follow, there is always a series of defensive strikes against the inevitable readjustment in wages, defeat, and partial disintegration. Then comes a period of turning to politics, panaceas, and schemes of humanitarian and social reform. With the recurrence of the business cycle there is a rebuilding of the unions and the order is repeated. We recognize that we are just now passing from the first to the second stage of such a cycle. Are we going into the third stage in the near future? This is the kind of question which a study of "the long swing," like this history, raises.

Few will pick up this history and read it entire. The more's the pity. With its great value we wish it were more readable. The facts have not been sifted. All are there, but with little or no emphasis on their relative importance. The reader finds it difficult to sift and interpret them, and until someone has done it for him the work of the authors wil not come to its full fruition.

It seems too bad that the American spelling—"labor"—should not have been used in the title and throughout the book. As it is, neither the American nor the English spelling has been adhered to, also in numerous cases the captions on opposite pages disagree and in portions of the text both spellings occur repeatedly within a dozen lines. One can forgive this, however, for the unique contribution rendered by the book. Not the least of its merits is a very full bibliography of nearly fifty pages which should prove a great help to students of this subject.

Management engineering *658*

THE ORGANIZATION OF MODERN BUSINESS

By William R. Basset

Publisher, Dodd, Mead and Company, New York

REVIEWED BY EDWARD S. COWDRICK

Assistant to Vice-President, Colorado Fuel and Iron Company

MR. BASSET'S new book comprises a rapid survey of the whole field of business management from the viewpoint of an industrial engineer—and an industrial engineer who has both feet very firmly planted on the ground. Discarding altruistic theories, the author accepts as his major premise that business is conducted for the purpose of making a profit for the owner through rendering acceptable service to the customer. The dozen altogether readable chapters which make up the book are devoted to exposition of methods of carrying out this theory of business.

Mr. Basset emphasizes specialization and standardization. He believes the salesman should market precisely the output of his factory, not attempt to take orders for products which require readjustments of manufacturing processes. He says:

A unit of business is a tool with which to do a certain job. The plant itself—that is, the structure of the building, its location and all that concerns it—partake also of the tool idea and are, whenever possible, to be designed exclusively for the work in hand.

This idea of specialization—of making sure just what you are going to do and then doing that one thing—the author thinks ought to be extended to financial policies. There is a sharp distinction, he asserts, between manufacturing and speculating in raw or finished materials, and this distinction should be kept constantly in mind when deciding upon corporation policies. Mr. Basset writes:

Most of the dangers in business finance arise out of putting the speculative side above the fabricating or merchandizing. It is just as dangerous for a corporation to speculate in goods as to speculate in the stock market. The first policy, therefore, to be determined in any business institution is whether the strictly business or the strictly speculative feature shall dominate.

While advocating standardization, Mr. Basset does not approve the extreme overorganization which tends to make a so-called executive little more than a glorified errand boy. He says:

An organization is nothing of itself. When one speaks of the automatic, smooth-running machinery of Big Business, one is talking nonsense. The wheels do not go around of themselves;

they must be propelled by leadership. There is more danger, we are just beginning to realize, from over-organization than from under-organization, because the former discourages leadership.

A refreshingly unconventional chapter is devoted to prices and profits. Mr. Basset refuses to discuss these subjects on ethical grounds, maintaining that the real solution is along lines simply of good business. Referring to the fear that, with profits unrestricted, shoes may sometime be selling for $75 a pair, he says:

Fifty years ago most workmen went barefooted in summer because shoes were considered too expensive to be worn heedlessly. There is abundant evidence to sustain the conclusion that feet were made primarily to stand on rather than to give aid and comfort to shoe-makers. But today very few people think of going barefooted at any time of the year. Now, if shoes are held at such a price that the ordinary person cannot buy a pair then he will go barefooted, and although at first going barefooted may roughly use the tender feet, the makers of shoes will suffer more than the owners of feet.

In his discussion of labor policies, too, the author departs from beaten paths. "What is a good labor policy?" he asks; and replies, "This can be answered in a single sentence. A good labor policy is one that works."

Passing to the subject of unionism, he says:

The trades union, although it has performed a valuable service in curbing unscrupulous and therefore short-sighted employers and has thus benefited business—even if unwittingly—has not of itself permanently advanced wages or bettered working conditions. The unions have merely, from time to time, registered the price that the increasing volume of capital must pay for the services of man.

Some of Mr. Basset's readers will accept all his conclusions; some will not. His book is to be commended, however, as a mental tonic to the business man whose economic thinking is in danger of going stale.

ERRATUM

In the October issue of MANAGEMENT ENGINEERING the last paragraph of the article "The 100 Per Cent Time Premium Plan," by L. V. Estes, should be changed to read: "The incentive held out to the workers makes possible a high rate of efficiency, maximum quality production per man, greatly *decreased* costs, and increased profits," instead of "greatly *increased* costs," as was printed.

RELATIVE INDEX FOR DECEMBER 1921

The following index is based upon the so-called "Brussels" classification. It is prepared especially for MANAGEMENT ENGINEERING by the United Engineering Societies Library, and is a part of the general plan used by them for classifying and indexing all engineering literature. A description of the system and the manner in which it is employed in MANAGEMENT ENGINEERING will be found in the July, 1921, issue, pages 49-52.

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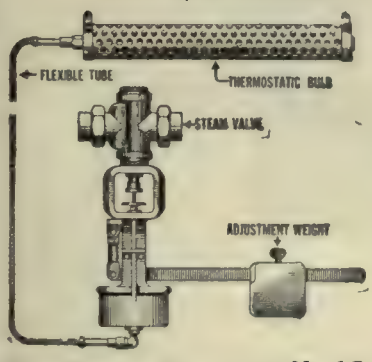

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